EUROPEAN GMD MISSION TEST CONCEPT

October 1, 2007

EXECUTIVE SUMMARY

The Missile Defense Agency is planning to expand the Ground-based Midcourse Defense (GMD) element of the Ballistic Missile Defense System (BMDS) to include new, two-stage Ground-based Interceptors (GBIs) in Poland and an X-band radar (referred to as the European Midcourse Radar (EMR)) in the Czech Republic. These European assets are planned to provide defenses against long-range Iranian threats to the United States as well as against intermediate-range Iranian threats to Europe.

The proposed GMD expansion to the European theater has not accomplished system engineering adequate to support the development of a test program sufficiently detailed to certify a high probability of working in an operationally effective manner once deployed. However, in spite of the lack of system engineering requirements for the European GMD assets, a basic test concept can be devised that is adequate to test the features necessary to execute the high level objectives of the European GMD mission, namely defense of Europe and the United States from Iranian threats.

This document discusses such a test concept. The discussion is organized in the following way. Section 1 is a background section describing the known Missile Defense Agency's plans for expanding GMD into the European theater. This is followed by a discussion of the existing BMDS testbed in Section 2. This testbed was originally designed to test the GMD element against the North Korean threat but has sufficient flexibility to test many (but not all) important aspects of European missile defense. The GMD European mission is then discussed in Section 3, including the defense of Europe and the defense of the United States from Iranian threats. Kinematic and geographical features of the European missile defense mission that impact the design of the test program are discussed. These features include the distance between the GBI launch site in Europe and Iran, the distance between the European GBI launch site and the EMR, and the distance between the European GBI launch site and the Upgraded Early Warning Radar (UEWR) in Fylingdales, England. In the 4th section, based in part on these kinematic and geographical features, the BMDS testbed assets that are likely candidates for testing European GMD capabilities are listed and discussed. The testbed assets that seem to be best suited for testing European scenarios include the long-range target launch site on Kodiak Island, Alaska, air-launched intermediate range targets, the UEWR at Beale Air Force Base in California, the test GBI launch site at Vandenberg Air Force Base (also in California), the Sea-based X-band radar, and an AN/TPY-2 X-band radar located in Alaska. Features of European missile defense that should be reflected in the test program are listed in Section 5. Twenty-one distinct features are identified that cover the EMR, the new two-stage GBI, battle management in the European theater and the warfighter concept of operations. Section 6 then discusses the proposed test program. The proposed test program starts with three flight tests:

- A flyout test of the two-stage interceptor planned for deployment in Poland

  Flyout of two-stage interceptor from Vandenberg Air Force Base (VAFB) engaging a simulated long-range target flying a trajectory similar to that from Iran to the United States. The interceptor must fly a steep trajectory to intercept such a threat.

- An intercept flight test using the two-stage interceptor

  Intercept of a threat representative intermediate-range air-launched target by the two-stage GBI launched from VAFB.

- A combined intercept/sensor flight test

  Tracking and intercept of multiple threat representative intermediate-range targets from air-launched platforms along with a long-range threat representative target launched from Kodiak Island. Interception of both the intermediate range targets by the new interceptors and the long-range threat by simulated two- and three- stage interceptors (sim-over-live).

These flight tests should provide sufficient data for minimally accrediting the models and simulations used in BMDS ground testing. The amount of flight testing proposed here is insufficient to gain statistical confidence in the effectiveness of the European GMD assets since each of the flight tests is, in effect, a unique test event investigating different required capabilities. Ground testing and wargames are necessary for expanding the range of the European missile defense battlespace sampled through this proposed test program.

Section 7 of this document discusses the "dual-use" features of the European test program, i.e., features of European missile defense that are not unique to the European mission but are equally relevant to the original GMD mission to defend against North Korean threats. These features can, and should, be part of the existing test program. A discussion of the features that are currently planned to be tested, as well as those for which no plans for testing currently exist, is included. Lastly, the document concludes with a summary in Section 8.

I. BACKGROUND

The Missile Defense Agency is planning to expand the Ground-based Midcourse Defense (GMD) element of the Ballistic Missile Defense System (BMDS) to include Ground-based Interceptors (GBIs) in Poland and an X-band radar in the Czech Republic. These European assets are planned to provide defenses against long-range Iranian threats to the United States as well as against intermediate range Iranian threats to Europe. The interceptor missile will be a derivative of the existing GBI but, instead of the current three-stage booster, the European interceptor will have only two stages. The X-band radar, referred to as the European Midcourse Radar (EMR), will be the existing Ground-based Radar Prototype (GBR-P) that will be moved from its current location in the Marshall Islands to the Czech Republic. The Upgraded Early Warning Radar-Fylingdales (UEWR-Fylingdales) in the United Kingdom will also provide support to the European GMD missions. In addition, one or more forward deployed AN/TPY-2 radars can be expected to provide early warning of missile launches and cueing to the EMR. Aegis Long Range Surveillance and Track (LRS&T) ships could also provide similar data.

Despite the apparent similarities between the new two-stage booster (and its associated launch hardware and software) and the existing three-stage booster, the effectiveness of the European GMD assets cannot be assumed. This is due in large part to the significant differences between the battlespace for the European assets defending against Iranian missile threats and that of the existing GMD assets whose primary focus has been to provide defenses against long-range North Korean missile threats. The hardware and software in the two-stage booster might be reasonably well understood, but the employment of this booster in European defensive operations is not. The EMR is a reasonably well-understood radar, but operations in the European theater present new challenges that must be fully investigated to ensure its overall effectiveness in carrying out the European missile defense mission. Additionally, successfully integrating these new assets into a concept of operations (CONOPS) that incorporates the new mission area of European missile defense will be a significant challenge to the warfighter. A robust test program is necessary to assess the operational effectiveness of these European

GMD assets when employed by typical warfighers using appropriately developed CONOPS.

The proposed GMD expansion to the European theater has not accomplished system engineering adequate to support the development of a test program sufficiently detailed to certify a high probability of working in an operationally effective manner once deployed. The types of system engineering activities necessary to develop a detailed test and evaluation program include: determining the engagement timelines for defense against both strategic threats to the United States and intermediate range threats to Europe; performance characteristics necessary for the two-stage European GMD interceptor to be used given these engagement timelines; lethality requirements for the types of engagements expected in the European theater; sensor timelines needed to support a successful engagement; communications timing requirements necessary to exchange data between European GMD assets and the BMDS; and an assessment of the ancillary needs of European GMD assets (logistics, site defense, power requirements, etc.). However, even without system engineering requirements for the European GMD assets, a basic test concept can be devised sufficient to test the features necessary to execute the high level objectives of the European GMD mission, namely defense of Europe and the United States from Iranian threats.

Note that the European *BMDS* mission is broader than the European *GMD* mission. The European BMDS mission must consider complex interactions between BMDS weapon elements operating in the European theater. These elements include GMD, Aegis Ballistic Missile Defense, Terminal High Altitude Area Defense, and Patriot Advanced Capability-3. Examining such interactions through BMDS-level flight testing is necessary to gain an understanding of how these elements work together in an operationally-realistic environment. However, it is too early to design such tests because the capabilities of the GMD element performing its European missile defense mission are not known. Thus, only a test concept for the European GMD mission based on the basic physics and kinematics of hit-to-kill missile defense as well as the geometric constraints imposed by basing GBIs in Poland and the EMR in the Czech Republic is feasible at this time.

This document discusses such a test concept. It will no doubt be refined as European missile defense system engineering requirements become available. The discussion is organized in the following way. In Section 2, the existing BMDS testbed is described. This testbed, originally built to test GMD capabilities against long-range North Korean threats, is the foundation upon which testing the European missile defense assets must be built. The GMD European mission is discussed in Section 3, including the defense of Europe and the defense of the United States from Iranian threats. Kinematic and geographical features of the European missile defense mission that impact the design of the test program are discussed. Based in part on these kinematic and geographical features, the BMDS testbed assets (primarily sensors and launch sites) that are likely candidates for testing European GMD capabilities are listed and discussed in Section 4. In Section 5, features of European missile defense that should be reflected in the test program are listed. The proposed test program is discussed in Section 6. This discussion includes flight and ground testing, modeling and simulation, and comparisons between the flight test scenarios proposed and European threat scenarios. Finally, in Section 7, this document concludes with a discussion of "dual-use" features of the European test program, i.e., features of European missile defense that are not unique to the European mission but are equally relevant to the original GMD mission to defend against North Korean threats. These features can, and should, be part of the existing test program. A discussion of the features that are currently planned to be tested, as well as those for which no plans for testing currently exist, is included.

II. CURRENT BMDS TESTBED

The BMDS testbed consists primarily of three fixed launch sites, some fixed sensor sites, and some mobile sensors. The three fixed launch sites are the Reagan Test Site on the Kwajalein Atoll (which used to launch GBIs), Kodiak Island (launches target vehicles), and Vandenberg Air Force Base (VAFB) (capable of launching both target vehicles and GBIs). The fixed sensor sites include UEWR-Beale in California, Cobra Dane on Shemya Island in Alaska, and the GBR-P in Kwajalein. The mobile sensors include the Sea-based X-Band (SBX) radar, Aegis Long Range Surveillance and Track (LRS&T) ships, and the AN/TPY-2 radar (currently located at VAFB). A map of the BMDS testbed, including range rings centered on each of the three fixed launch sites, is shown in Figure II-1.

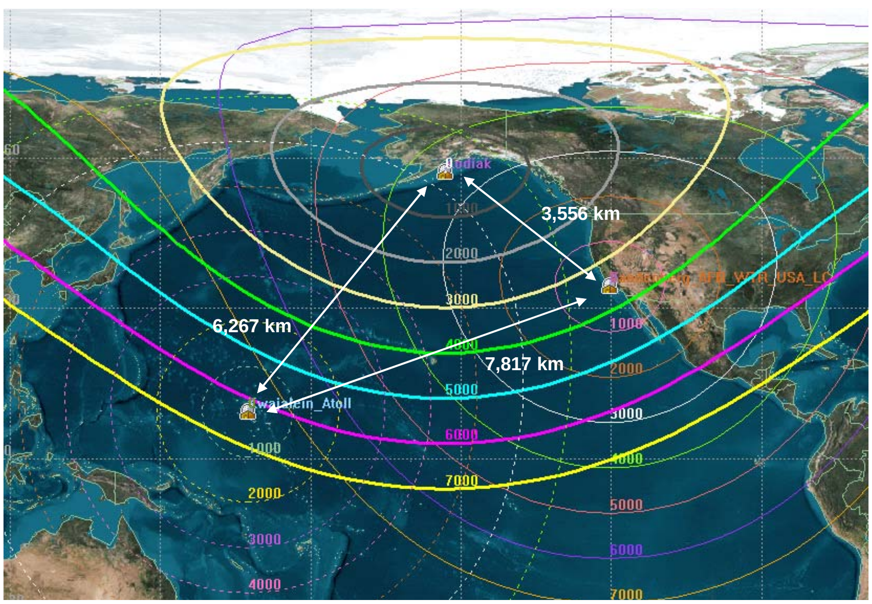


Figure II-1: Map of the BMDS testbed. Range rings are centered on each of the three fixed launch sites in Kwajalein Atoll, Kodiak Island, Alaska and Vandenberg Air force Base.

This testbed was originally designed for testing the GMD element of the BMDS. The threats of interest were located in North Korea and all had a minimum range of about 5,000 km (to reach Alaska) to more than 8,000 km (necessary to reach the continental United States). The GBI launch site in Fort Greely, Alaska is more than 5,500 km away from North Korea. The nearest GMD fixed site sensor to North Korea, the Cobra Dane radar on Shemya Island in Alaska, is about 3,800 km from North Korea. The relative geometry between the North Korean threat launch sites, the forward-based Cobra Dane radar, and the GBI launch site at Fort Greely ensures that most, if not all, GBI engagements of North Korean threats occur in the midcourse phase of the threat fly-out. Terminal (or late) engagements, where both the threat and the GBI are traveling with generally downward trajectories are possible in some cases.

III. GMD EUROPEAN MISSION

The GMD assets in Europe are planned to simultaneously participate in the defense of Europe from intermediate-range Iranian threats and in the defense of the U.S. homeland from long-range Iranian threats. These two missions are very distinct, with little overlap in the capabilities that must be demonstrated. Figure III-1 shows a map with range rings centered on Tehran, Iran (to approximate the threat) and on Warsaw, Poland (to approximate the GBI launch site). Observe that the GBI launch site in Europe is only about 3,000 km away from launch sites in Iran. This is more than 2,500 km closer to the threat launch site compared to the distance between Fort Greely and North Korea. The EMR will be located relatively close to the European GBI launch site, quite unlike the situation in the Pacific. These differences in relative geometry will have significant impact on designing European missile defense tests.

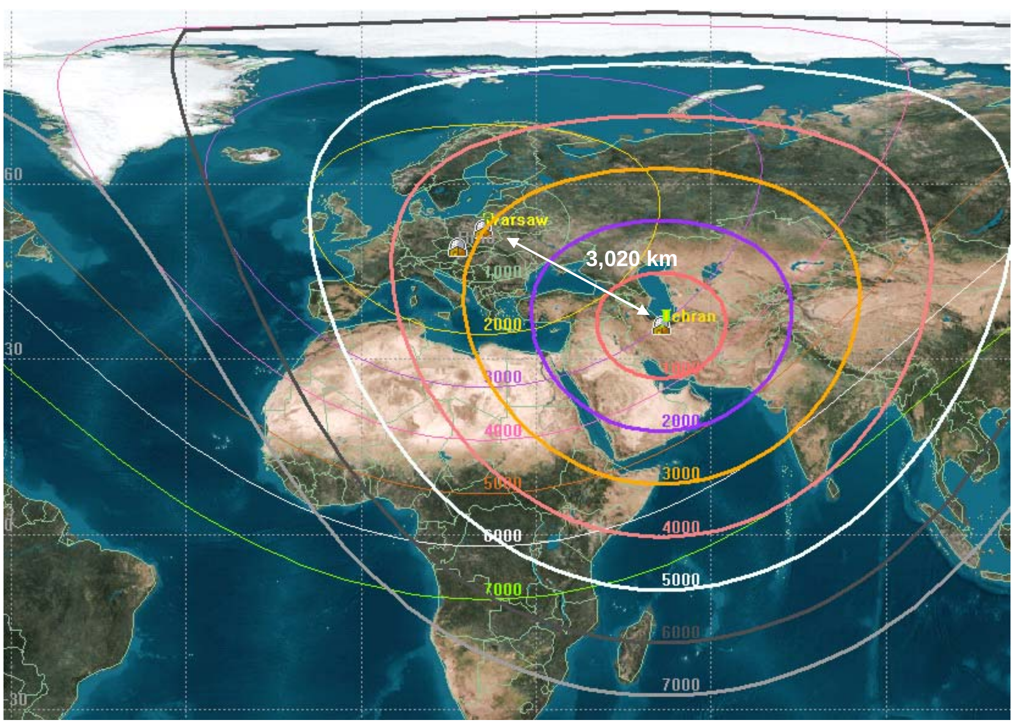


Figure III-1: Map of European theater with range rings centered on Tehran, Iran and Warsaw, Poland.

A. EUROPEAN DEFENSE

European defense using GMD assets is a completely new mission area for GMD as it requires GMD to engage intermediate-range ballistic missiles. To date, GMD has not had a requirement to provide such a capability and thus it is completely untested regarding intermediate-range threats. The major differences between engaging intermediate-range threats and intercontinental threats are a lower threat apogee and a decrease in engagement timeline. This, coupled with the decreased distance between both the GBI launch site and EMR to the threat launch sites, makes battle management a significant challenge for European defense. It is also reasonable to expect European defense to involve multiple, simultaneous engagements of intermediate-range threats, since such threats are cheaper and easier to build compared to long-range threats. Figure III-2 shows a map of Europe annotated with the range from Tehran, Iran, to several major European capitals that are part of the North Atlantic Treaty Organization (NATO). Note that the European threat ranges go from a minimum of about 3,000 km to a maximum of about 4,800 km.

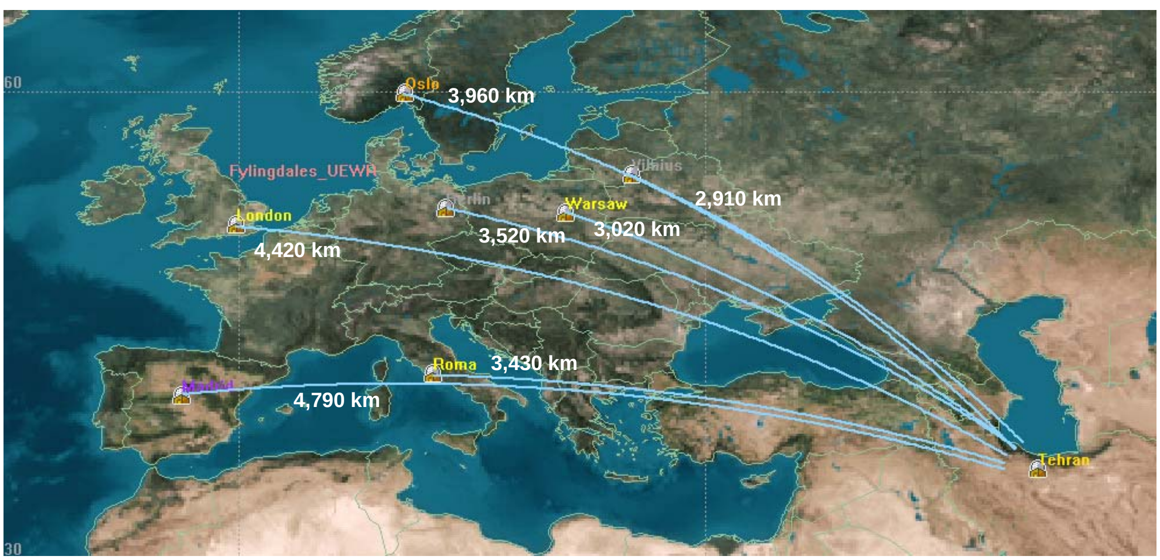


Figure III-2: Map of Europe showing distance between Tehran, Iran, and major European cities.

Figure III-3 shows notional threats launched from Iran against the European cities shown in Figure III-2. These threats are minimum energy trajectories built by Satellite Toolkit based on notional launch conditions. Note that minimum energy trajectories tend to be relatively slow, providing best case estimates in terms of battlespace timelines for this analysis. Accurate threat trajectories require detailed boost phase data as well as the physical characteristics of the payload (throw weight, size, etc.). These details have not been incorporated into this analysis. Thus, the results presented here are sufficient to provide ballpark estimates of European engagements of Iranian threats, which should be sufficient for determining the major features of a test program designed to provide data to evaluate the effectiveness of European missile defense. The magenta stars that overlay each trajectory represent one-minute intervals of target flight time. The color codes for sensor coverage are described in the figure legend. Note that large portions of the trajectories are observed by multiple radars.

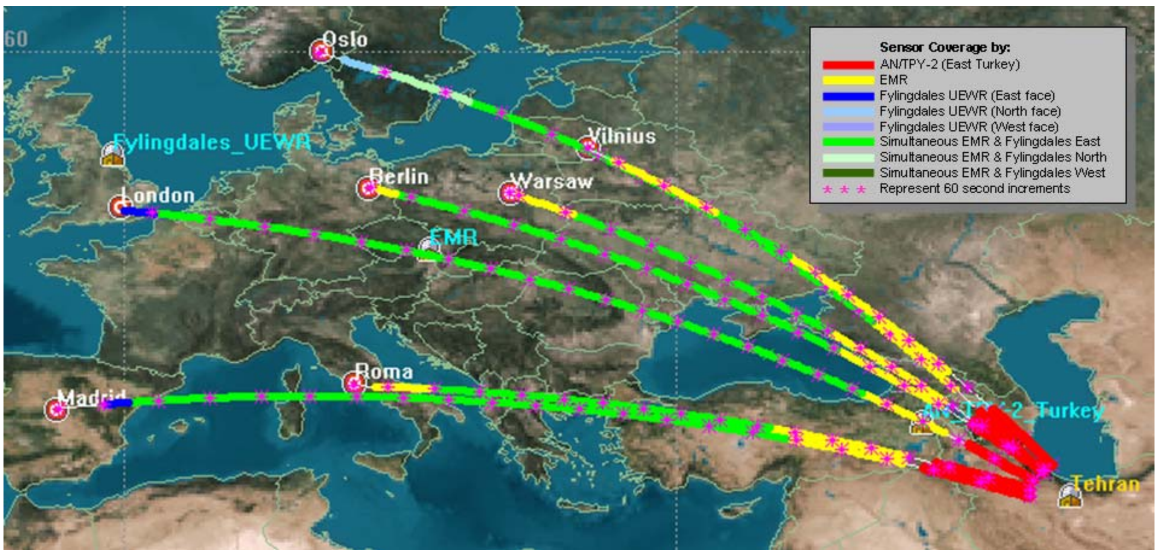


Figure III-3: Notional Iranian threats launched against major European cities.

From a kinematic viewpoint, intercepting the threat to the southeast of the GBI launch site is preferred as these intercept locations potentially provide the highest closing velocities, which increases the lethality of these engagements. Intercepting Iranian threats to the west of the GBI launch site puts the GBI into a "tail-chase" which decreases the closing velocity and, therefore, the lethality of these engagements. For intercepts to the southeast of the GBI launch site, there is generally less than 15 minutes after detection of the target before an intercept must occur.

B. U.S. DEFENSE

U.S. defense from Iranian threats using European-based GMD assets requires the GMD element to operate in a battlespace quite unlike that required for defense against North Korean threats. In this case, engagement timelines are compressed due to the close proximity of both the GBI launch site and EMR to threat launch locations in Iran. Given the relative geometry between the GBI and threat launch location, all intercepts of long-range threats occur during the post-boost, ascent phase of the trajectory. These intercepts must occur to the southeast of the GBI launch site to avoid a "tail-chase". Thus, GMD operates more as an ascent phase defense system rather than a midcourse phase defense system. Figure III-4 shows the ranges from Tehran, Iran, to various points in the United States.

Figure III-4: Threat ranges from Iran to points in the United States.

Figure III-5 is similar to Figure III-3, except the threats are being launched to points in the United States. These threat trajectories were also built using Satellite Toolkit based on notional launch parameters. Like Figure III-3, accurate threat trajectories require detailed boost phase data as well as the physical characteristics of the payload (throw weight, size, etc.). These details have not been incorporated into this analysis.

A significant difference between defense of Europe and defense of the United States is that if the European GMD assets fail to negate the threat, then the original components of the GMD element must engage the threat. Therefore, additional testing is needed in the case of defending the United States to ensure that, if the European GMD assets fail to kill the target, the probability of successfully engaging the threat using the remaining GMD components is not degraded. Additional testing should include demonstration of reliable kill assessment, which is crucial to reengagement. Currently, no assets have been identified to provide kill assessment.

Observe that the space between magenta stars in Figure III-5 is significantly larger than that in Figure III-3. This is due to the larger velocity of strategic threats compared to intermediate range threats. This has the effect of decreasing the engagement timeline compared to threats against Europe. This decrease will have a significant impact on battle management and human-in-control activities. Also observe that all of these threats are observed by additional faces of the UEWR-Fylingdales.

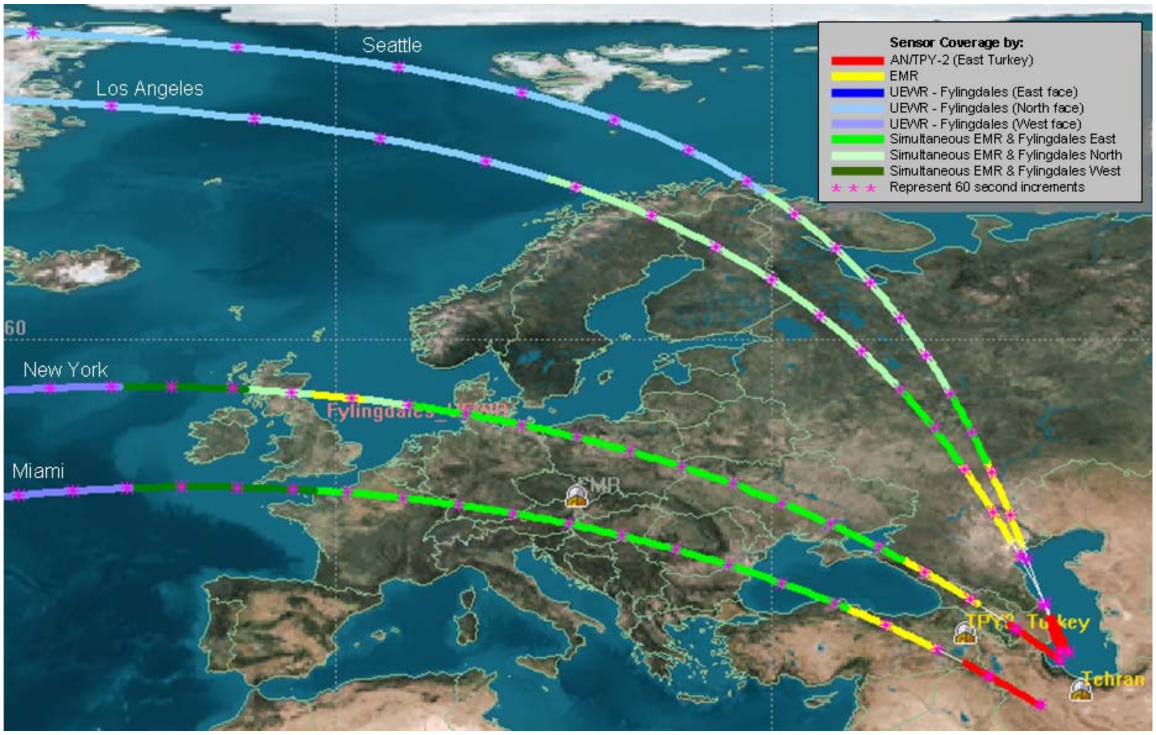


Figure III-5: Notional Iranian threats to the United States.

IV. TEST ASSETS

Three major classes of test assets are necessary to adequately test European missile defense capabilities. These are battle management, sensors, and interceptors. These assets must replicate, as much as possible, the relative geometry of the European GMD assets and the Iranian threat as well as the actual capabilities of the GMD assets.

A. BATTLE MANAGEMENT

The operational GFC has been used in previous test events and should be used for testing European GMD assets.

B. TESTBED SENSORS

The GBR-P, currently located at Kwajalein Atoll, is the actual radar that will be moved to Europe to act as the EMR. Thus, it would appear to be an excellent sensor to use in testing European GMD capabilities. However, the GBR-P at Kwajalein is too distant from the other two fixed launch sites (Kodiak and VAFB) to participate in realistic testing of European GMD capabilities. Therefore, either the GBR-P must be moved to a more suitable location for testing or a suitable surrogate must be found. The Sea-Based X-band (SBX) radar is such a surrogate. The SBX is a more powerful radar than the GBR-P, but it should be possible to reduce its performance to accurately mimic GBR-P radar performance, perhaps by modification of the transmitted waveforms. That, plus the SBX's inherent mobility make this radar an excellent choice for testing European missile defense capabilities.

UEWR-Beale is very similar to the UEWR-Fylingdales, so it is a natural sensor to choose for testing European missile defense. Cobra Dane points in the wrong direction to participate in almost any type of intercept flight testing and there are no plans to deploy a radar like Cobra Dane in the European theater. Thus, it is not a viable candidate for testing European capabilities. It is very likely that Aegis LRS&T ships and the AN/TPY-2 radar will be deployed in the European theater. Such sensors would probably be used to cue the EMR. Therefore, they should also be included in testing of European missile defense capabilities. In summary, if suitable test geometries can be found, then UEWR-Beale, SBX, Aegis LRS&T, and AN/TPY-2 sensors are all viable sensors that should participate in testing GMD capabilities to defend Europe.

C. INTERCEPTOR AND TARGET LAUNCH SITES

Of the two current interceptor launch sites (Kwajalein Atoll and VAFB), Kwajalein is too distant from the target launch sites (Kodiak and VAFB) to participate in realistic testing of GMD capabilities to defend against Iranian threats. This leaves VAFB as the only viable launch site currently in the BMDS testbed. Hawaii is a possible location for building a new GBI launch site from a range perspective (about 4,000 km from both Kodiak Island and VAFB). Compare this to the approximately 3,000 km range from Tehran to Warsaw. However, the geometry of a potential Hawaiian GBI launch site with UEWR-Beale in California does not do a good job of approximating the relative locations of the UEWR-Fylingdales and European GBI launch site. Therefore, a Hawaiian GBI launch site does not offer any significant advantages to testing. Unfortunately, UEWR-Beale and the VAFB GBI launch site also do not have the same relative geometry as the UEWR-Fylingdales and the European GBI launch site. However, there should be ways to mitigate the mismatch between UEWR-Beale and the VAFB GBI launch site geometry and that of the European GBI launch site and UEWR-Fylingdales. Details are discussed in an upcoming section. In summary, of the current testbed GBI launch sites, only VAFB offers a realistic launch location. Of course, a mobile GBI launch capability for the testbed would make test design considerably simpler. Such a mobile launch capability would likely be expensive and difficult, since not only a GBI launcher is required, but also the associated Command Launch Equipment and In-Flight Interceptor Communications System.

Of the two current fixed target launch sites, only Kodiak Island in Alaska is a candidate launch site. Both long-range and intermediate-range target missiles can be launched from Kodiak Island. The other target launch site at VAFB is basically co-located with the interceptor launch site, which is not at all realistic.

Mobile, air-launched targets provide an extremely flexible launch capability for intermediate-range targets. Because such targets are launched from standard cargo aircraft, near simultaneous launch of multiple air-launched targets and ground launched targets is possible.

V. FEATURES OF THE TEST PROGRAM

Table V-1 lists features of European missile defense that should be reflected in any test program. Some of these features are not unique to missile defense using European GMD assets and should be part of any robust test and evaluation program. Many of these features have, unfortunately, not been addressed in the current test program or have been insufficiently addressed. Other features are unique to the European missile defense assets and would not be tested as part of the existing test and evaluation program.

Table V-1: Features of missile defense using European GMD assets.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Impact
1	Threat trajectories will be observed by both the EMR and one face of UEWR-Fylingdales.	Euro		GMD Fire Control (GFC) must exercise sensor fusion algorithms
2	Threat trajectories will be observed by both the EMR and more than one face of UEWR-Fylingdales.	U.S.		GFC must exercise sensor fusion algorithms.
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory.	Both		GFC must exercise sensor fusion algorithms.
4	Engagement timelines are shorter than for North Korean engagements considered thus far.	Both	✓	GFC must be able to plan engagements quicker than in the past.
5	Intercepts **must** occur during the ascent phase of long-range threat.	U.S.	✓	Result of the short engagement timelines
6	Intercept of multiple, intermediate- and long-range threats	Both	✓	GFC must manage significantly more complex threat scenarios.
7	GBI will consist of two-stage interceptor.	Both	✓	New, as yet untested interceptor
8	GBI launch site and EMR are in relatively close proximity compared to North Korean engagements considered thus far.	Both	✓	GBI – EMR geometry is unlike any tested thus far.
9	Both GBI launch site and EMR are relatively close to threat launch site compared to North Korean engagements considered thus far.	Both	✓	Primary cause of short engagement timelines
10	Logistics for silo-based ICBM-class missiles based, for the first time, on foreign soil.	Both	✓	Maintainability of interceptors might be more difficult
11	GBIs will be observed by at least one face of UEWR-Fylingdales.	Both		GFC must be able to identify friend or foe.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Impact
12	Weapons-free must be issued quicker than North Korean engagements.	Both	✓	Warfighters have less time to determine threat or non-threat.
13	European GMD operations must not degrade existing GMD capabilities.	Both	✓	Based on recent experience, adding sensors to GMD can cause unexpected difficulties to existing capabilities.
14	EMR should be able to simultaneously track multiple intermediate range targets.	Euro	✓	Intermediate range threats are cheaper and easier to build than long-range threats. Proportionally more intermediate range threats compared to long-range threats can be expected when hostilities commence.
15	European GMD assets should be able to interoperate with other BMDS elements in theater.	Both		Aegis BMD and THAAD interceptors might be observable by GMD sensors due to the smaller physical battlespace in Europe.
16	GFC must choose between 2-stage and 3-stage variants of the GBI.	Both	✓	GFC must prioritize defended regions and then optimize GBI inventories during engagement planning.
17	Targets should be threat representative of intermediate range Iranian threats.	Euro	✓	Intermediate range threats are new to GMD.
18	Targets should be threat representative of long-range Iranian threats.	U.S.		Iranian threat does not yet exist.
19	Anticipate rules of engagement will be different between North Korean threats and Iranian threats due to differences in engagement timelines.	Both	✓	Warfighter must quickly and accurately determine the appropriate rules of engagement.
20	CONOPS for allocation of resources for simultaneous threats against Europe and the United States in a resource limited environment	Both	✓	GFC and the warfighter must have clearly defined CONOPS to aid in quickly making decision regarding allocation of limited resources, specifically European-based GBIs.
21	Energy management maneuvers for a two-stage interceptor	Both	✓	Energy management maneuvers are probably different for long-range and intermediate-range threats.

VI. PROPOSED TEST PROGRAM

Based on the complexity of the European missile defense mission, simply deploying the two-stage GBIs in Poland and the EMR in the Czech Republic and integrating them into the existing GMD architecture does not assure an effective missile defense capability. As shown in Table V-1, many features of missile defense using European GMD assets are unique to the European theater. Even some of those features that are not unique to the European theater have yet to be tested. Thus, a robust test program is required. Simply testing the new two-stage booster in a flight test (even an intercept flight test) is inadequate to assess the operational effectiveness of the European deployment of GMD assets. A well-planned campaign of flight and ground testing, along with validated and accredited modeling and simulation, is necessary for any determination of operational effectiveness.

A. METHODOLOGY AND SCOPE

The test concept that follows is a high-level analysis, with the purpose of designing test scenarios that will stimulate the system in an operationally-realistic way for European defense assets. It does not attempt to model interceptor behavior. Realistic target trajectories and radar tracks feed GFC the proper information to plan an intercept, regardless of interceptor capabilities.

The proposed flight test scenarios were created using Satellite Toolkit to model minimum energy threat trajectories and radar access times. Detailed knowledge of threat launch points, trajectories and exact radar locations may change the sensor access times shown in the report, but the overall timeline and necessary sensor fusion tasks remain the same. System engineering assessments of European GMD capabilities are necessary for building a detailed test program.

The goal of the test concept is to design a test program that builds upon itself to collect the data necessary for minimally accrediting models. Gaining statistical confidence in European GMD capabilities is not a goal of the proposed test program.

B. FLIGHT TESTING

Flight testing must incorporate the following objectives:

- Fly-out of operational two-stage interceptor

- Observation of threat by both EMR (surrogate SBX) and UEWR-Fylingdales (surrogate UEWR-Beale)
- Cueing of EMR (surrogate SBX) by either Aegis LRS&T or AN/TPY-2
- Shortened timeline compared to North Korean engagement timelines
- GFC selection of two-stage interceptor over three-stage interceptor
- UEWR-Fylingdales (surrogate UEWR-Beale) face crossings
- EMR (surrogate SBX) tracking of multiple intermediate range threats

Demonstrating these objectives in flight tests that are as operationally realistic as possible should collect the data needed for a minimal accreditation of the models and simulations that will be used in ground testing. Waivers to operational realism in these flight tests to enhance collection of data to support validation of modeling and simulation should be considered on a case-by-case basis. Note that all of the features above cannot be achieved in a single, realizable intercept flight test event.

The three flight tests described below should be able to meet all of the objectives listed above. Note that the target launch and aimpoints are approximate. The actual flight test target launch and aimpoints should be adjusted for the best estimate of the Iranian threat capabilities as well as the capabilities of the actual sensors and two-stage interceptors.

The test scenarios below were designed by first fixing the interceptor launch site at VAFB. The test geometry is then built around VAFB to simulate the relative geography of missile defense engagements in the European theater. Because SBX is the most mobile sensor, it can be optimally located relative to VAFB to simulate the relative geographic locations of the GBI launch site in Poland and the EMR. Then, the test targets can be launched in such a manner to simulate the relative geometry between Iranian threats to specific aimpoints, the GBI launch site in Poland, and the EMR. Unfortunately, UEWR-Beale is much closer to VAFB than UEWR-Fylingdales is to the European GBI launch site. One possible technique to overcome this problem is described in the flight test descriptions. The AN/TPY-2 radar in Juneau, Alaska, (planned for FTG-04) has the least flexibility in the scenarios proposed below. However, the exact location of the AN/TPY-2 in the European theater is not known at this time, so this is currently not a major issue. All that is required of the AN/TPY-2 in the test scenarios described below is the ability to successfully pass data to the SBX.

Each of the flight test descriptions consists of a brief synopsis, similar to the descriptions provided in high level documents such as the Integrated Master Test

Baseline, and a detailed description and rationale (as detailed as possible without specific requirements for the European missile defense mission).

- Two-stage Interceptor Flyout Test

  Synopsis – Flyout of two-stage interceptor from VAFB engaging a simulated long-range target flying a trajectory similar to that from Iran to the United States. The interceptor must fly a steep trajectory to intercept such a threat.

  Detailed Description and Rationale – An interceptor flyout, rather than an intercept test, allows two important test attributes: (1) verification of the new booster configuration and EKV deployment before the GBI faces a live target, and (2) a simulated intercept where the target and interceptor are both headed "up", which is necessary for U.S. defense from Europe, but not possible during an intercept test because of orbital debris concerns.

  Figure VI-1 shows a map of the simulated threat trajectory. As in the previous figures, the magenta stars represent one minute of trajectory flight time. The geometry of this threat has been chosen to mimic many of the kinematic features of an Iranian threat launched against New York City. New York City was selected because it is the closest high value target to Iran and, given the relatively unsophisticated threat expected from a first generation Iranian long-range missile, it seems unlikely Iran would attack lesser valued targets at longer ranges.

  An important feature of this simulated trajectory is that it flies almost directly over VAFB, mimicking the behavior of the Iranian threat to New York which flies directly over Poland, the European GBI launch site (see Figure III-5). The simulated target launch site was selected to approximate the timeline for the Iranian threat to New York. Additional system engineering of the European GMD mission and detailed test planning are required to pinpoint the most realistic launch site for this simulated target. Sensor observation times can be approximated and input to the GFC, which should then compute an appropriate intercept solution.

  The trajectory selected stresses the engagement timeline since the GBI must intercept the simulated target before it flies over VAFB because the GBI cannot (for range safety reasons) be launched to the east. Thus, the interceptor flyout and EKV post-deployment activities must be accomplished in a short time-frame to permit interception of the simulated target. Additional constraints include other aspects of VAFB range safety, flyout fans, and safe broad ocean area impact. UEWR-Beale (acting as a UEWR-Fylingdales surrogate) will track the interceptor and send that data to the GFC. GFC or the warfighter operators must make a friend or foe determination and act accordingly.

The simultaneous launch of an intermediate-range target from either Kodiak Island or an air-launch platform which is tracked by the SBX (acting as an EMR surrogate at an appropriate location) and flies across the face of UEWR-Beale would provide more realistic sensor loads for the GFC to handle. Such targets could be flown with trajectories that would not complicate the primary objective, and would also serve as risk reduction for upcoming intercept flight tests. However, they are not essential to the two-stage intercept flyout.

C2BMC displays would be used to assess situational awareness.

- Intercept Flight Test

Synopsis – Intercept of a threat representative intermediate-range air-launched target by a two-stage GBI launched from VAFB.

Detailed Description and Rationale – An AN/TPY-2 forward deployed to Alaska (similar to current plans for FTG-04) would be used to cue the SBX

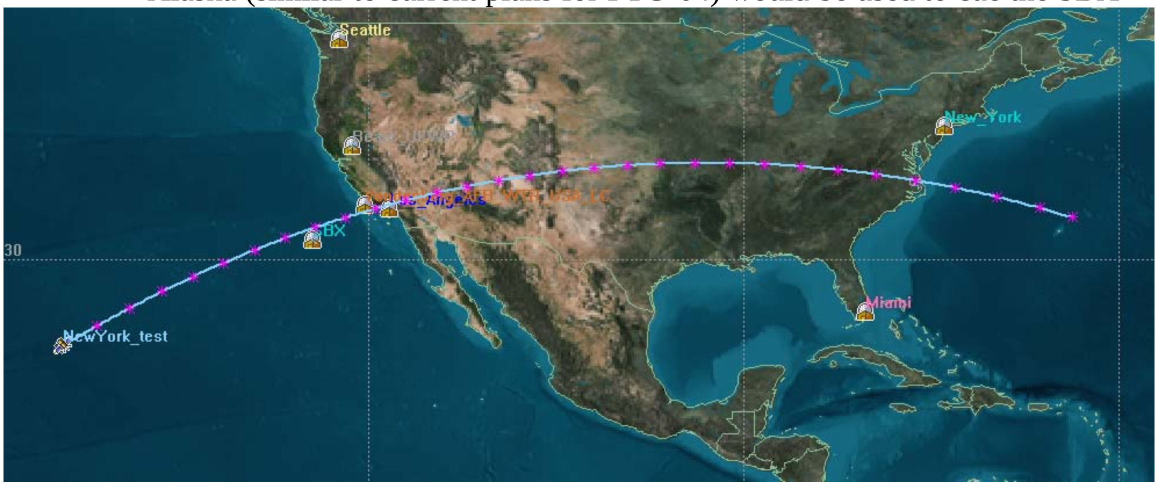


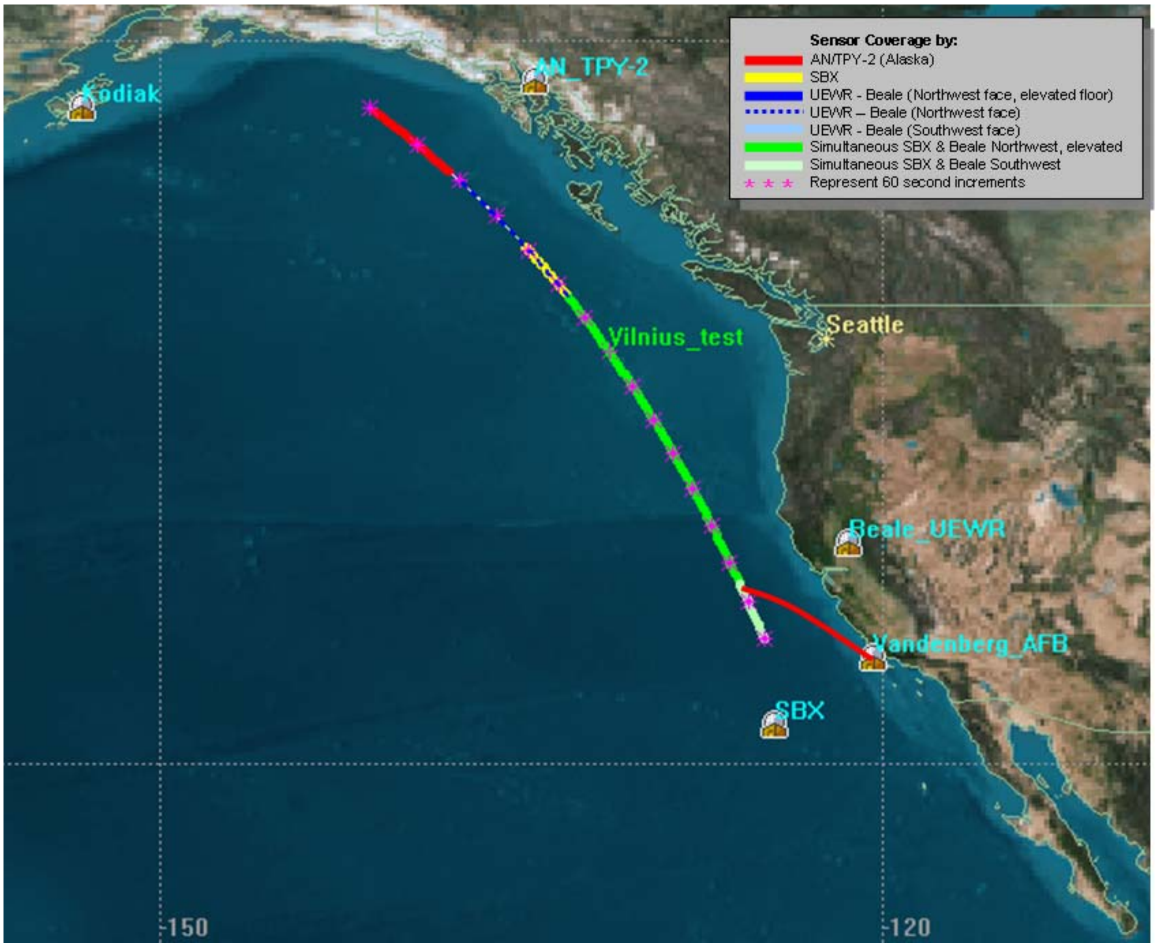
Figure VI-1: Simulated trajectory used by GFC to launch the two-stage GBI from VAFB.

(acting as an EMR surrogate). The SBX would be located the same distance from VAFB as the EMR is from the GBI launch site in Poland.

The SBX must begin tracking the target **before** UEWR-Beale (acting as a UEWR-Fylingdales surrogate) to be consistent with the expected behavior in the European theater. This would require tracking from UEWR-Beale to be modified to simulate the distance between the European GBI launch site and UEWR-Fylingdales. This can be accomplished by adjusting the search fence of the northwest-looking face of UEWR-Beale to a minimum elevation around 17 degrees. Note that simply withholding UEWR-Beale track data from the GFC is not sufficient since the Beale track would be unrealistically accurate once it was released to GFC. UEWR-Beale would also track the interceptor after it was launched and send that data to GFC.

GFC and the warfighters must determine the friend or foe status of the GBI.

The target trajectory, depicted in Figure VI-2, is representative of an Iranian threat launched toward Vilnius, Lithuania. The target impact location is about 400 kilometers from the GBI launch site at VAFB, simulating the distance between Polish GBI launch site and Vilnius. It also simulates an Iranian threat targeting the EMR site. This trajectory was selected because it potentially requires energy management maneuvers to achieve a successful intercept and has a stressing engagement timeline. The portion of the target trajectory covered by the dashed, dark blue line is observable by UEWR-Beale with its normal search fence. Observe that the target is observable by UEWR-Beale before the SBX (represented by the yellow line). By adjusting the UEWR-Beale search fence to around 17 degrees above the horizon, the portion of the target trajectory observable by UEWR-Beale (and SBX) is decreased to that shown by the light-green line. Compare this target trajectory to that of the Vilnius threat shown in Figure III-3.



The two-stage interceptor flyout trajectory shown in red is notional. The actual two-stage interceptor flyout depends on the energy management capabilities of the GBI and the exact flyout computed by the GFC. These parameters cannot be determined without more specific system engineering of European GMD operations.

C2BMC would be used for tasking AN/TPY-2, providing AN/TPY-2 data to GFC, and its displays would be used to assess situational awareness.

- Combined Intercept/Sensor Flight Test

Synopsis – Tracking and intercept of multiple threat representative intermediate-range targets from air-launched platforms along with a long-range threat representative target launched from Kodiak Island. Interception of both the intermediate range targets by two-stage interceptors and the long-range threat by simulated two- and three- stage interceptors (sim-over-live).

Detailed Description and Rationale – An AN/TPY-2 forward deployed to Alaska (similar to current plans for FTG-04) would be used to cue the SBX (acting as an EMR surrogate). The SBX would be located the same distance from VAFB as the EMR is from the GBI launch site in Poland.

The SBX must begin tracking the target **before** UEWR-Beale (acting as a UEWR-Fylingdales surrogate) to be consistent with the expected behavior in the European theater. This would require tracking from UEWR-Beale to be modified to simulate the distance between the European GBI launch site and UEWR-Fylingdales. This is accomplished in a manner similar to the previous interceptor flight test by adjusting the search fence of the northwest-looking face of UEWR-Beale to a minimum elevation around 17 degrees. UEWR-Beale would also track the two-stage interceptors after they are launched from VAFB and send that data to GFC. GFC and the warfighters must determine the friend or foe status of the GBI.

The intermediate-range target trajectories, depicted in Figure VI-3, are representative of an Iranian threat launched toward Vilnius, Lithuania (or against the EMR site) and Rome, Italy. The impact locations for these targets are about 400 and 1,300 kilometers from the GBI launch site at VAFB respectively, simulating the distance between Polish GBI launch site and Vilnius and Rome. European defense is likely to involve multiple, simultaneous engagements of intermediate-range threats, since such threats are cheaper and easier to build compared to long-range threats, and are therefore anticipated to be more numerous than the long-range threats.

Figure 2: Trajectory of air-launched target for proposed intercept flight test.

The long-range target launched from Kodiak simulates a threat launched to the East coast of the U.S. between New York and Miami (e.g., Washington D.C.). It flies through both faces of the UEWR-Beale. GFC must plan a simulated intercept of this actual flight test target using a simulated two-stage interceptor launched from VAFB (dotted red line in Figure IV-3). A kill assessment should then be performed, reporting back to GFC that the threat was not negated. GFC should then launch a simulated three-stage interceptor, appropriately mapped to the testbed to simulate a launch from Fort Greely, Alaska. Defended areas should also be appropriately mapped to stimulate GFC. A simulated two-stage intercept of the long-range threat is necessary to ensure that GFC behavior based on real-time sensor data from multiple sources (the X-band radar, UEWR, and AN/TPY-2) is sufficient to plan an effective engagement against the long-range target using European GBIs. This part of the combined intercept/sensor flight test is the complement of the first flyout test where the target was simulated and the interceptor was real. The second simulated intercept using a simulated

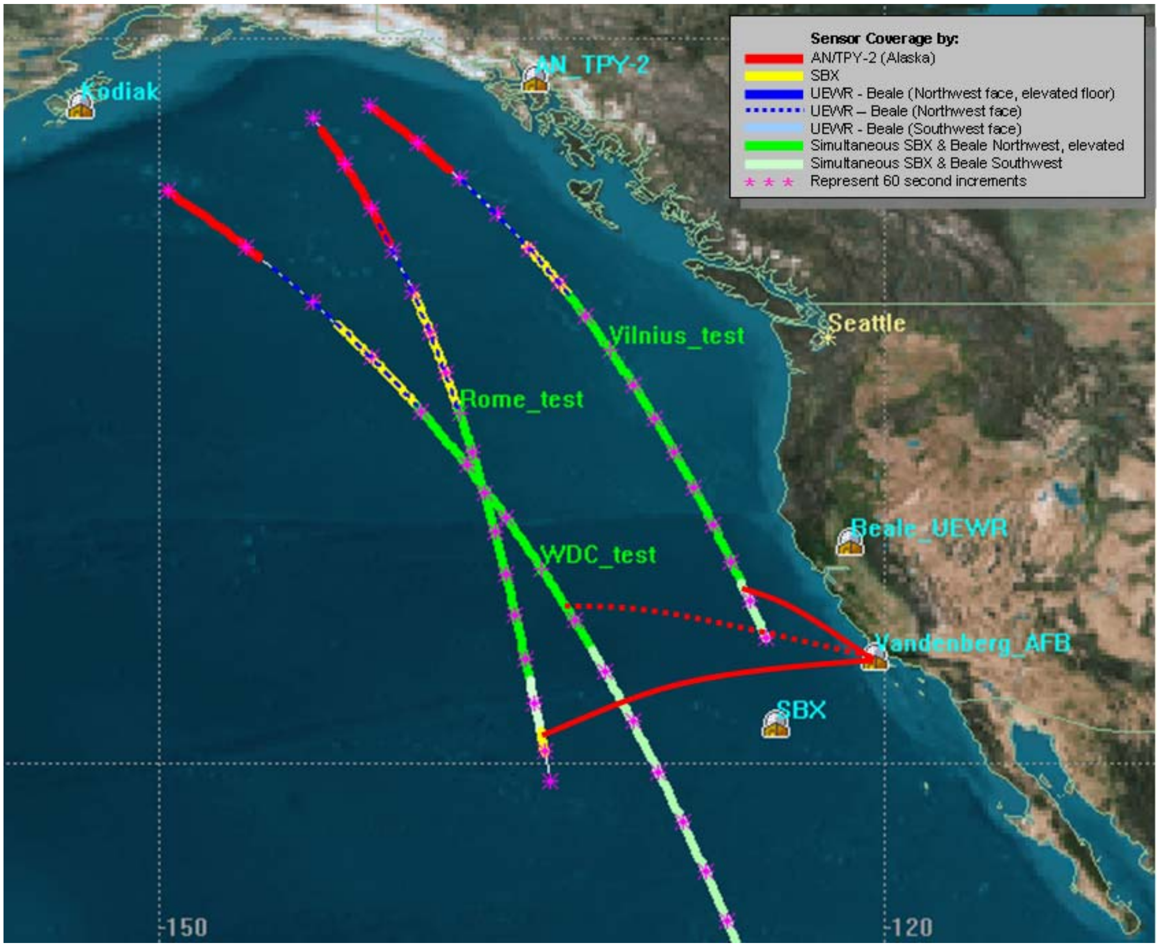


Figure VI-3: Trajectory of targets for proposed combined intercept/sensor test.

three-stage interceptor is necessary to ensure that the original GMD mission, which uses Fort Greely-based GBIs, is not degraded by including data from the EMR in the process of building weapon task plans. It is important that the long range target emulate a realistic Iranian long-range threat (including any debris or other unexpected objects), so that realistic X-band data and data from UEWR-Beale (which will have the target crossing from one face to another) can be fused by GFC to generate the appropriate weapon task plans.

As in the previously described flight test, the two-stage interceptor flyout trajectories shown in red are notional, with the dashed line denoting a simulated fly-out. The actual two-stage interceptor flyout depends on the energy management capabilities of the GBI and the exact flyout computed by the GFC. These parameters cannot be determined without more specific system engineering of European GMD operations. The two GBIs launched against the intermediate range threats are actual, physical GBIs while the GBIs launched against the long range threat (one a two-stage interceptor and the other a three-stage interceptor) are simulated. Figure VI-3 does not show the simulated three-stage GBI trajectory, which would intercept the target far to the south of VAFB.

As in the previous test, C2BMC would be used to task AN/TPY-2, provide AN/TPY-2 data to GFC, and its displays would be used to assess situational awareness.

C. COMPARISON BETWEEN PROPOSED FLIGHT TESTS AND OPERATIONAL SCENARIOS

The methodology for testing and evaluating the European GMD assets is based on stimulating the GMD element (both sensors and battle management) in a manner consistent with the expected operational scenarios in the European theater. Interceptor performance is then tested by arranging the test target trajectories such that the interceptor flyout and dynamics mimic, to the maximum extent possible, the flyout geometry expected in the European theater.

Figure VI-4 shows a comparison of sensor observation times between the test flight scenario simulating the Iran to Vilnius (or, similarly, Iran to EMR site) threat scenario. Observe that the observation timelines for the AN/TPY-2 and the SBX are comparable to those for the operational sensors (AN/TPY-2 and EMR). Of these test sensors, the SBX matches the threat scenario the best because it is the most mobile sensor and can therefore be positioned to optimally simulate the EMR. The UEWR-Beale coverage does not match the Vilnius threat very well because of range restrictions. Instead, it is more representative of an Iranian threat launched against the EMR. The

AN/TPY-2 sensor is a good match because the air-launched target is close to the AN/TPY-2 radar in Juneau, Alaska.

Figure VI-5 shows a similar plot of sensor observation times for the Iran to Rome threat. All the sensors in the test scenario are a good match for the operational scenario.

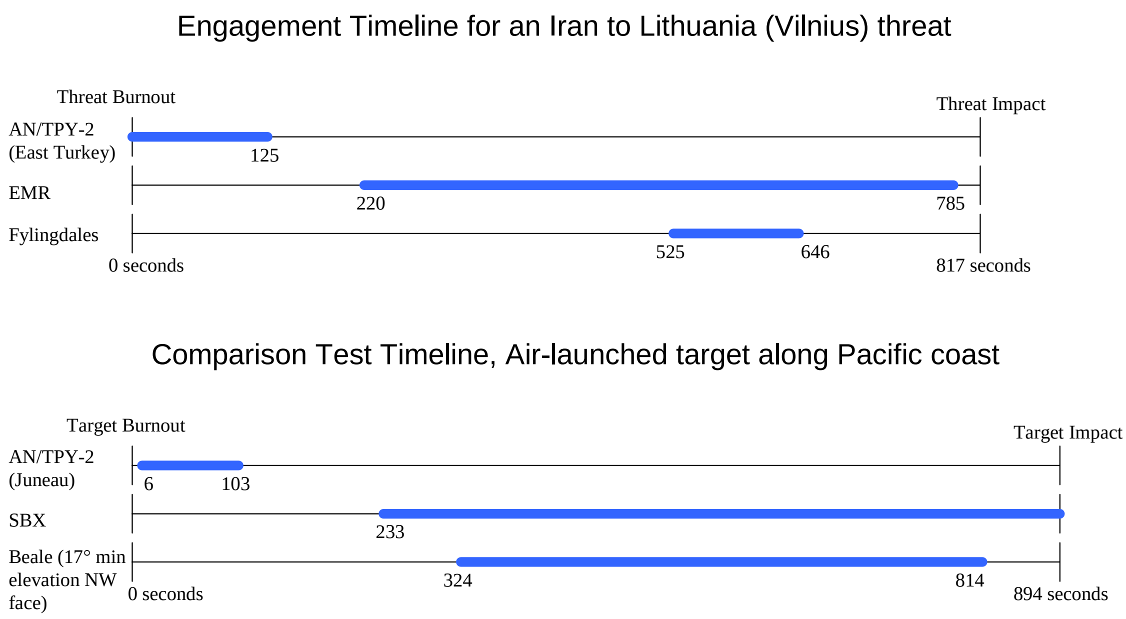


Figure VI-4: Comparison of sensor timelines between operational (top) and test (bottom) scenarios for Iran to Vilnius scenario.

Figure VI-6 shows a similar plot of sensor observation times for long-range threats from Iran. In this case, the Iranian threat to New York has a complicated set of UEWR-Fylingdales sensor observations. Because this threat flies almost directly over UEWR-Fylingdales, it is observed by all three faces of the radar (represented by different colors on the engagement timeline). The gap between the light blue observations occurs when the target is directly over Fylingdales. Complicated sensor observations such as these are difficult to replicate in the Pacific testbed because ballistic targets generally cannot fly directly over UEWR-Beale and UEWR-Beale does not have three faces like UEWR-Fylingdales. Thus, in the test scenario, the UEWR-Beale observations are considerably less complicated. In spite of this, sufficient data should be collected to anchor models and simulations of UEWR-Fylingdales and the complicated scenario for Iranian threats to New York can be studied via ground testing and wargames.

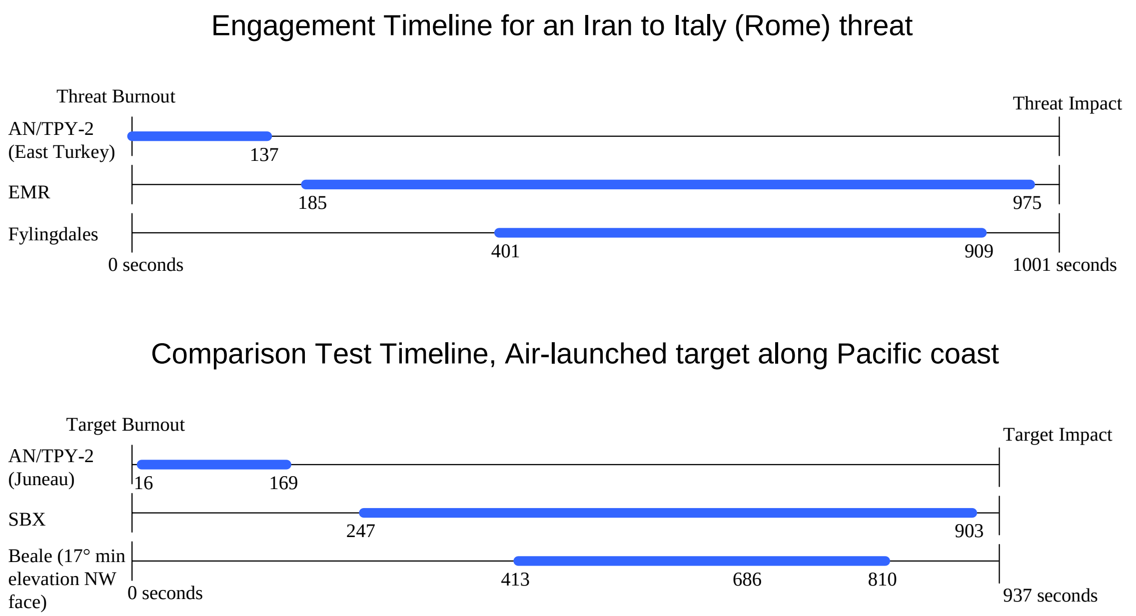


Figure VI-5: Comparison of sensor timelines between operational (top) and test (bottom) scenarios for Iran to Rome scenario.

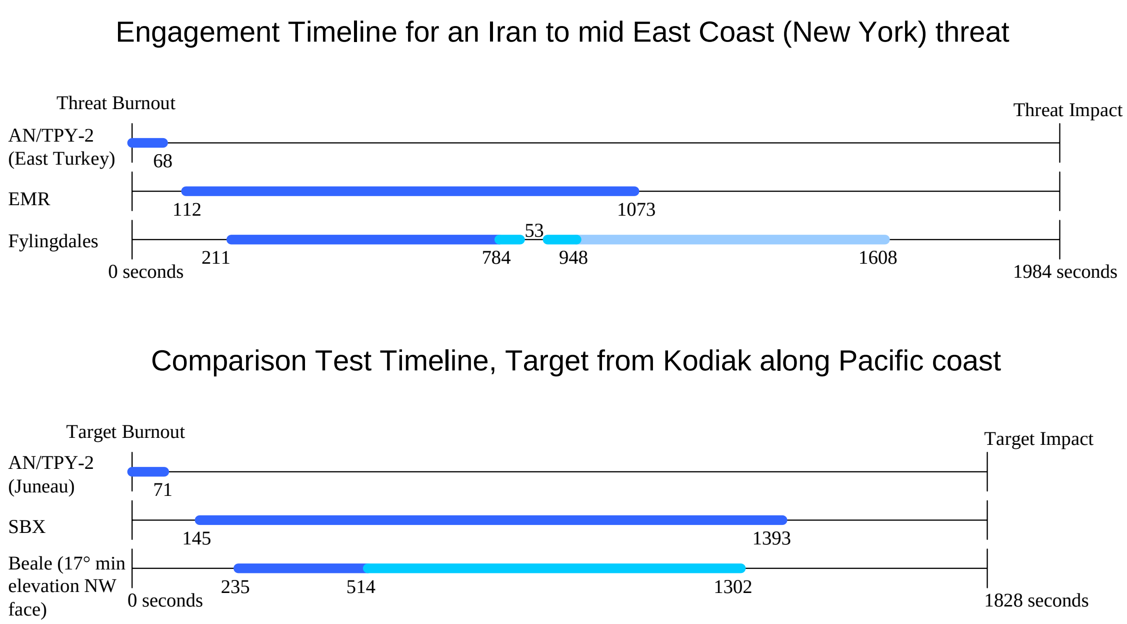


Figure VI-6: Comparison of sensor timelines between operational (top) and test (bottom) scenarios for long-range Iranian threats to the United States.

Along with engagement timelines, the range between the target and the sensor is an important factor to consider. If the range is too close in the test scenarios compared to the threat scenarios, the signal-to-noise ratio will be greater in the test scenarios and could enhance tracking, classification, and ultimately interception. This would result in over-estimating the capability of the European GMD assets. Likewise, if the range is further than the threat scenarios, the capability of the European GMD assets could be underestimated.

Figure VI-7 shows a plot of the range between the target (the threat in the operational scenarios and the test target in the test scenarios) and the associated X-band radar (either the EMR or SBX). Because of the mobility of the SBX, it can be situated to optimally match the threat scenarios. This accounts for the very good match between the operational scenarios and proposed flight test scenarios.

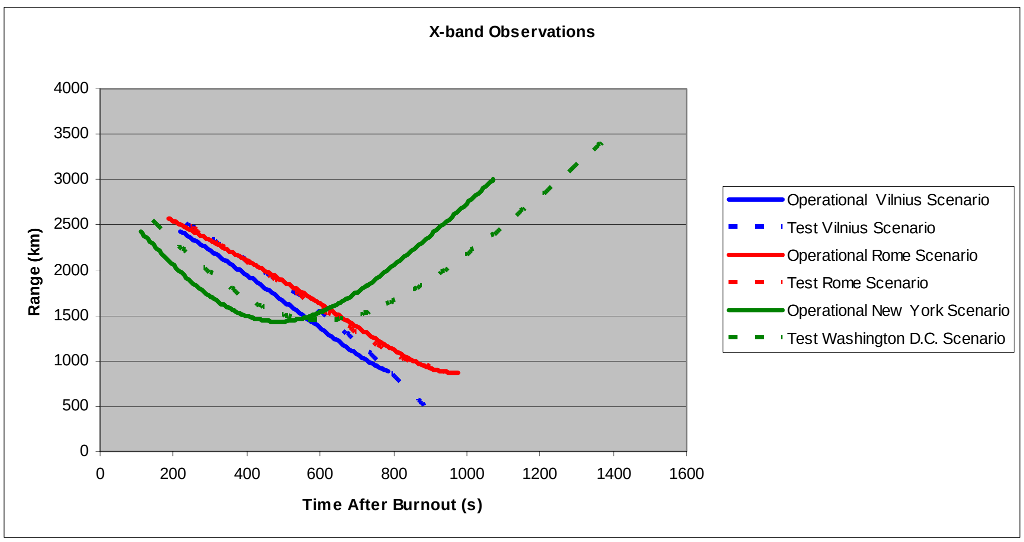


Figure VI-7: Comparison of range to X-band radar for operational (solid line) and test (dotted line) scenarios.

Figure VI-8 shows a similar plot for the UEWRs. Observe that the test targets are always significantly closer to UEWR-Beale than the threats are to UEWR-Fylingdales (by as much as 1,000 kilometers or more). Elevation of the UEWR-Beale search fence can modify the test scenario engagement timeline to match that of the threat, but it cannot make the range between the target and the radar larger. To compensate for this effect, data from UEWR-Beale must be adjusted in terms of signal-to-noise to match the performance of UEWR-Fylingdales in the European theater.

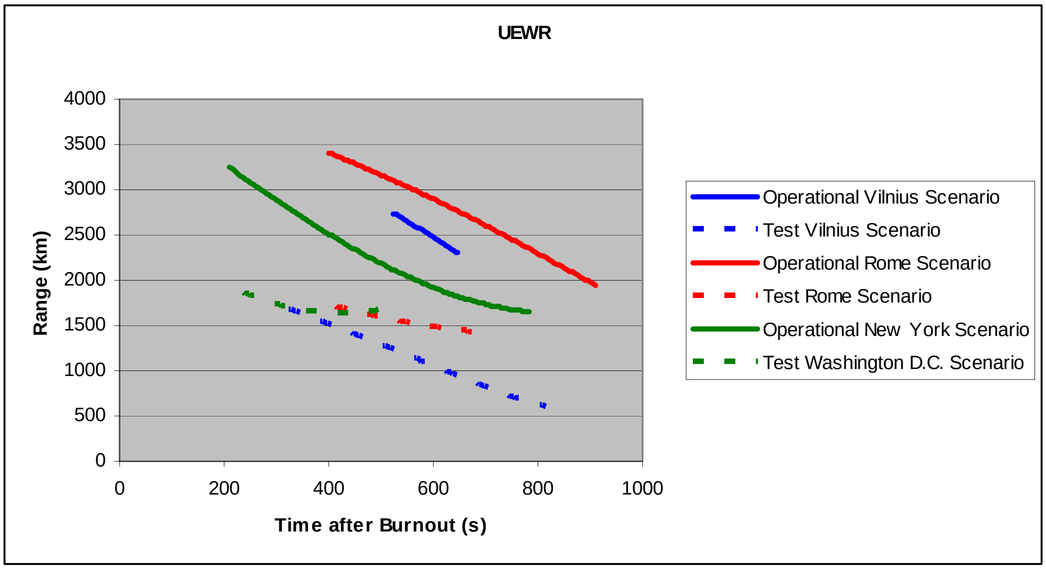


Figure VI-8: Comparison of range to UEWR for operational (solid line) and test (dotted line) scenarios.

Finally, Figure VI-9 shows the same plot for the AN/TPY-2. Because little effort has been made to match the test and European AN/TPY-2 radar geometries, the operational ranges do not match the test ranges very well. Since the radar is needed only for passing data to the SBX in the test scenarios, this should not be a major problem.

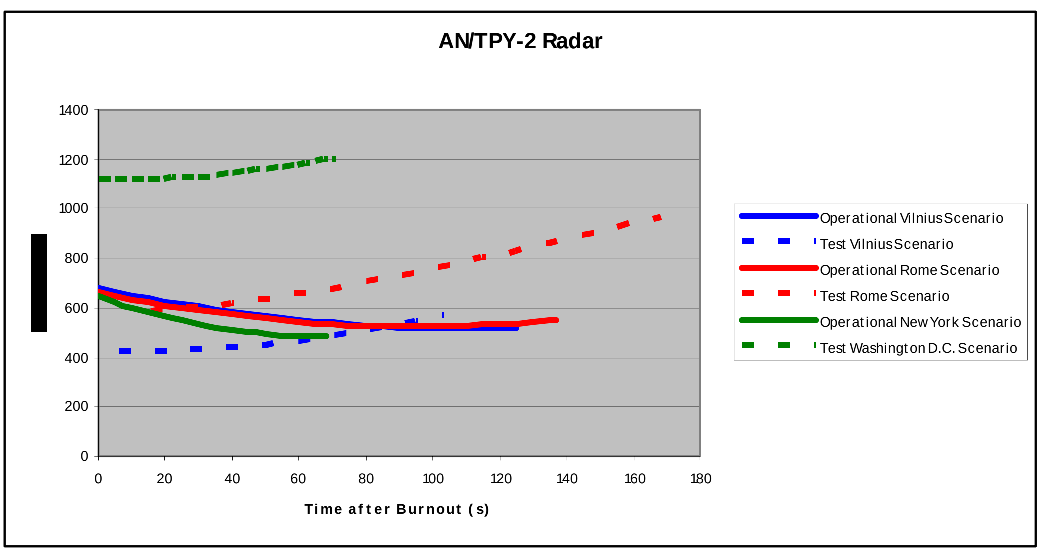


Figure VI-9: Comparison of range to AN/TPY-2 radar for operational (solid line) and test (dotted line) scenarios.

Of the three tests described above, the Combined Intercept/Sensor Flight Test is obviously the most complex as it involves multiple threats (both intermediate- and long-range), multiple sensors, a variety of inputs to GFC and sim-over-live events. This test could be separated into two flight tests (one focused on the intermediate-range targets and one focused on the long-range targets), however the combined test is a likely, operationally realistic scenario that would be encountered in the European theater.

Features that should be testable by this flight test program are shown in Table VI-1.

Table VI-1: Features of European missile defense tested by proposed flight test program.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Tested by proposed flight test program?
1	Threat trajectories will be observed by both the EMR and one face of UEWR-Fylingdales	Euro		✓
2	Threat trajectories will be observed by both the EMR and more than one face of UEWR-Fylingdales	U.S.		✓
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory	Both		✓
4	Engagement timelines are shorter than for North Korean engagements considered thus far	Both	✓	✓
5	Intercepts **must** occur during the ascent phase of long-range threat	U.S.	✓	Not possible given current range restrictions
6	Intercept of multiple, intermediate- and long-range threats	Both	✓	Best tested via ground testing using accredited models
7	GBI will consist of two-stage interceptor.	Both	✓	✓
8	GBI launch site and EMR are in relatively close proximity compared to North Korean engagements considered thus far	Both	✓	✓
9	Both GBI launch site and EMR are relatively close to threat launch site compared to North Korean engagements considered thus far	Both	✓	✓
10	Logistics for silo-based ICBM-class missiles based, for the first time, on foreign soil	Both	✓	Not testable via flight tests
11	GBIs will be observed by at least one face of UEWR-Fylingdales	Both		✓
12	Weapons-free must be issued quicker than North Korean engagements	Both	✓	✓

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Tested by proposed flight test program?
13	European GMD operations must not degrade existing GMD capabilities	Both	✓	Best tested via ground testing using accredited models
14	EMR should be able to simultaneously track multiple intermediate range targets	Euro	✓	✓
15	European GMD assets should be able to interoperate with other BMDS elements in theater	Both		Best tested via ground testing using accredited models
16	GFC must choose between 2-stage and 3-stage variants of the GBI	Both	✓	✓
17	Targets should be threat representative of intermediate range Iranian threats	Euro	✓	✓
18	Targets should be threat representative of long-range Iranian threats	U.S.		✓
19	Anticipate rules of engagement will be different between North Korean threats and Iranian threats due to differences in engagement timelines	Both	✓	Best tested during ground tests and wargames using accredited models
20	CONOPS for allocation of resources for simultaneous threats against Europe and the United States in a resource limited environment	Both	✓	Best tested during wargames with warfighter operators
21	Energy management maneuvers for a two-stage interceptor	Both	✓	✓ (assuming does not violate VAFB safety restrictions)

D. MODELING AND SIMULATION VV&A

One of the major purposes of any missile defense flight test program should be verification, validation and accreditation (VV&A) of the models and simulations of the BMDS. This is critical because flight testing alone is insufficient to completely sample the entire GMD battlespace. Ground testing and wargames based on independently accredited models and simulations that expand the GMD operational envelope beyond the parameters sampled by flight testing are essential for any credible determination of operational effectiveness. This is especially true for European missile defense. The flight test program described above should provide data to support an accreditation of the appropriate models and simulations, assuming these flight tests do not discover unanticipated issues. If such issues are discovered, then additional testing (that almost certainly includes flight tests) will be required to demonstrate a complete understanding of the operational impacts of these issues. Table VI-2 maps the features of European missile defense to the flight test or tests that can provide appropriate VV&A data. In this table, the interceptor flyout test is referred to simply as flyout, the intercept test of the intermediate-range target is referred to as intercept, and the combined intercept/sensor test is referred to as combined. Note that some data from the current flight test program may also be applicable for VV&A of European assets.

Table VI-2: Mapping of European missile defense features to proposed flight tests that can provide VV&A data for models and simulations.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	VV&A data provided by proposed flight test program
1	Threat trajectories will be observed by both the EMR and one face of UEWR-Fylingdales	Euro		Intercept
2	Threat trajectories will be observed by both the EMR and more than one face of UEWR-Fylingdales	U.S.		Combined
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory	Both		Intercept, combined
4	Engagement timelines are shorter than for North Korean engagements considered thus far	Both	✓	Flyout, intercept, combined
5	Intercepts **must** occur during the ascent phase of long-range threat	U.S.	✓	Not possible given current range restrictions
6	Intercept of multiple, intermediate- and long-range threats	Both	✓	Best tested via ground testing using accredited models
7	GBI will consist of two-stage interceptor.	Both	✓	Flyout, intercept, combined
8	GBI launch site and EMR are in relatively close proximity compared to North Korean engagements considered thus far	Both	✓	Intercept, combined
9	Both GBI launch site and EMR are relatively close to threat launch site compared to North Korean engagements considered thus far	Both	✓	Flyout, intercept, combined
10	Logistics for silo-based ICBM-class missiles based, for the first time, on foreign soil	Both	✓	Not testable via flight tests
11	GBIs will be observed by at least one face of UEWR-Fylingdales	Both		Flyout, intercept, combined
12	Weapons-free must be issued quicker than North Korean engagements	Both	✓	Intercept, combined

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	VV&A data provided by proposed flight test program
13	European GMD operations must not degrade existing GMD capabilities	Both	✓	Best tested via ground testing using accredited models
14	EMR should be able to simultaneously track multiple intermediate range targets	Euro	✓	Combined
15	European GMD assets should be able to interoperate with other BMDS elements in theater	Both		Best tested via ground testing using accredited models
16	GFC must choose between 2-stage and 3-stage variants of the GBI	Both	✓	Combined
17	Targets should be threat representative of intermediate range Iranian threats	Euro	✓	Intercept, combined
18	Targets should be threat representative of long-range Iranian threats	U.S.		Combined
19	Anticipate rules of engagement will be different between North Korean threats and Iranian threats due to differences in engagement timelines	Both	✓	Best tested during ground tests and wargames using accredited models
20	CONOPS for allocation of resources for simultaneous threats against Europe and the United States in a resource limited environment	Both	✓	Best tested during wargames with warfighter operators
21	Energy management maneuvers for a two-stage interceptor	Both	✓	Flyout, intercept, combined

E. GROUND TESTING

Integrated ground testing should test the following objectives:

- Assess impact of European operations on existing GMD capabilities.
- Variety of simulated fly-out geometries of operational two-stage interceptor
- Observation of threat by both EMR and UEWR-Fylingdales. Cueing of EMR by either Aegis LRS&T or AN/TPY-2
- Shortened timeline compared to North Korean engagement timelines
- GFC correct selection of two-stage interceptor or three-stage interceptor for a variety of target aimpoints
- UEWR-Fylingdales face crossings
- EMR tracking of multiple intermediate range threats
- GFC performance in a mass raid environment

- European GMD engagement of multiple intermediate range threats
- Interoperate with other elements of the BMDS, notably Aegis BMD and THAAD

Distributed ground testing should add the following objectives to those above:

- Determine if European GMD assets successfully integrated
- Determine impact on existing GMD assets

In addition to integrated and distributed ground tests, wargames are essential to validate the warfighter CONOPS and test the rules of engagement for European missile defense. Also, the impact of European missile defense operations on the current GMD mission (from a warfighter perspective) can best be assessed through wargames based on independently accredited models and simulations.

Features that should be testable via ground tests based on accredited models and simulations are given in Table VI-3.

Table VI-3: Features of European missile defense testable via ground tests using accredited models and simulations.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Tested via ground tests using accredited models and simulations?
1	Threat trajectories will be observed by both the EMR and one face of UEWR-Fylingdales	Euro		✓
2	Threat trajectories will be observed by both the EMR and more than one face of UEWR-Fylingdales	U.S.		✓
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory	Both		✓
4	Engagement timelines are shorter than for North Korean engagements considered thus far	Both	✓	✓
5	Intercepts **must** occur during the ascent phase of long-range threat	U.S.	✓	✓
6	Intercept of multiple, intermediate- and long-range threats	Both	✓	✓
7	GBI will consist of two-stage interceptor.	Both	✓	✓
8	GBI launch site and EMR are in relatively close proximity compared to North Korean engagements considered thus far	Both	✓	✓
9	Both GBI launch site and EMR are relatively close to threat launch site compared to North Korean engagements considered thus far	Both	✓	✓

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Tested via ground tests using accredited models and simulations?
10	Logistics for silo-based ICBM-class missiles based, for the first time, on foreign soil	Both	✓	Not testable via ground tests
11	GBIs will be observed by at least one face of UEWR-Fylingdales	Both		✓
12	Weapons-free must be issued quicker than North Korean engagements	Both	✓	✓
13	European GMD operations must not degrade existing GMD capabilities	Both	✓	✓
14	EMR should be able to simultaneously track multiple intermediate range targets	Euro	✓	✓
15	European GMD assets should be able to interoperate with other BMDS elements in theater	Both		✓
16	GFC must choose between 2-stage and 3-stage variants of the GBI	Both	✓	✓
17	Targets should be threat representative of intermediate range Iranian threats	Euro	✓	✓
18	Targets should be threat representative of long-range Iranian threats	U.S.		✓
19	Anticipate rules of engagement will be different between North Korean threats and Iranian threats due to differences in engagement timelines	Both	✓	✓
20	CONOPS for allocation of resources for simultaneous threats against Europe and the United States in a resource limited environment	Both	✓	✓
21	Energy management maneuvers for a two-stage interceptor	Both	✓	✓

Table VI-4 is a rollup of the preceding three tables. It is presented here to show the progression from flight testing (which tests a single point in the European missile defense battlespace), though VV&A of models and simulations, and finally to fully accredited ground tests that sample a large fraction of the battlespace. Only upon successful completion of the ground testing phase can a determination of operational effectiveness for the European GMD assets be made.

Table VI-4: Rollup of Tables 2, 3 and 4.

ID	Feature	Euro or U.S. defense, or both (Defended Area)	Unique to Euro GMD fixed assets	Tested by proposed flight test program	Flight Test Data Sources			Tested via ground tests using accredited models and simulations
					Flyout	Intercept	Combined	
1	Threat trajectories observed by both EMR and one face of UEWR-Fylingdales	Euro		✓		x		✓
2	Threat trajectories observed by both EMR and more than one face of UEWR-Fylingdales	U.S.		✓			x	✓
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory	Both		✓		x	x	✓
4	Engagement timelines are shorter than for N. Korean engagements considered thus far	Both	✓	✓	x	x	x	✓
5	Intercepts **must** occur during the ascent phase of long-range threat	U.S.	✓			Not possible		✓
6	Intercept of multiple, intermediate- and long-range threats	Both	✓			Ground testable		✓
7	GBI will consist of two-stage interceptor.	Both	✓	✓	x	x	x	✓
8	GBI launch site and EMR are closer compared to N. Korean engagements	Both	✓	✓		x	x	✓
9	GBI launch site and EMR are closer to threat launch site compared to N. Korean engagements	Both	✓	✓	x	x	x	✓
10	Logistics for silo-based ICBM-class missiles based, for the first time, on foreign soil	Both	✓			Not flight testable		Not flight testable
11	GBIs will be observed by at least one face of UEWR-Fylingdales	Both		✓	x	x	x	✓
12	Weapons-free must be issued quicker than N. Korean engagements	Both	✓	✓		x	x	✓
13	Euro GMD operations must not degrade existing GMD capabilities	Both	✓					✓
14	EMR should be able to simultaneously track multiple intermediate range targets	Euro	✓	✓			x	✓
15	Euro GMD assets should interoperate with other BMDS elements in theater	Both				Ground testable		✓
16	GFC must choose between 2-stage and 3-stage variants of the GBI	Both	✓	✓			x	✓
17	Targets should be threat representative of intermediate range Iranian threats	Euro	✓	✓		x	x	✓
18	Targets should be threat representative of long-range Iranian threats	U.S.		✓			x	✓
19	Anticipate rules of engagement will be different between N. Korean and Iranian threats due to different engagement timelines	Both	✓			Ground testable		✓
20	CONOPS for allocating GBIs for simultaneous threats against Euro and U.S. in a GBI limited environment	Both	✓			Ground testable		✓
21	Energy management maneuvers for a two-stage interceptor	Both	✓	✓	x	x	x	✓

VII. “DUAL-USE” TESTING

Some of the features of European missile defense operations shown in Table V-1 are “dual-use”, that is, they are not unique to European missile defense. These features should be tested as part of the existing GMD test and evaluation program. Assessments of the effectiveness of the European GMD assets can be based on such tests. Table VII-1 gives of list of these dual-use features and states whether these features have already been investigated by the current flight test program to date. In some cases, these features are planned to be investigated in future flight tests.

Table VII-1: Dual-use testing features.

ID	Feature	Euro or U.S. defense, or both?	Unique to Euro GMD assets?	Tested by current flight test program?
1	Threat trajectories will be observed by both the EMR and one face of UEWR-Fylingdales	Euro	No	No. Planned for FTG-04, -05
2	Threat trajectories will be observed by both the EMR and more than one face of UEWR-Fylingdales	U.S.	No	No.
3	Aegis LRS&T and/or AN/TPY-2 will likely observe the threat trajectory	Both	No	No. Tested as part of integrated and distributed ground tests. Planned for FTG-04, -05
11	GBIs will be observed by at least one face of UEWR-Fylingdales	Both	No	No.
15	European GMD assets should be able to interoperate with other BMDS elements in theater	Both	No	No. Interoperability is a major objective of distributed ground testing
18	Targets should be threat representative of long-range Iranian threats	U.S.	No	No. Iranian threat does not yet exist.

VIII. SUMMARY

Despite the lack of detailed system engineering for the European missile defense mission, a robust flight test program can be laid out to test the capability of the European GMD assets. Three flight tests have been proposed that can anchor models and simulations used in ground tests and wargames. The flight tests sample a very small portion of the European missile defense battlespace, but they should be sufficient to provide a minimal VV&A of models and simulations. Ground tests and wargames are needed to expand the amount of battlespace sampled by testing.

The amount of flight testing proposed here is insufficient to gain statistical confidence in the effectiveness of the European GMD assets. Each of the flight tests is, in effect, a unique test event investigating different required capabilities of these assets. Statistical confidence is achieved by performing the same (or similar) tests repeatedly to determine the average behavior of a system. The flight tests proposed here do not have statistical confidence as a goal.

This proposed concept gives a high-level overview of a flight and ground test campaign with the necessary features to characterize the initial effectiveness of the European GMD assets. Depending on the outcomes of the proposed flight and ground tests, additional tests and/or modifications of the test program or the European GMD assets may be required. Logistics will need to be assessed via a demonstration event, or detailed review of maintenance and supply plans.