MEOSAR Performance Overview

SAR Controllers Training 2016
1 – 3 March 2016
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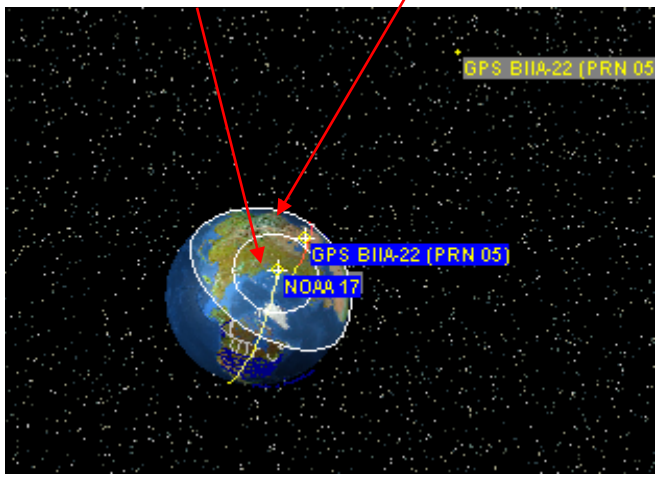
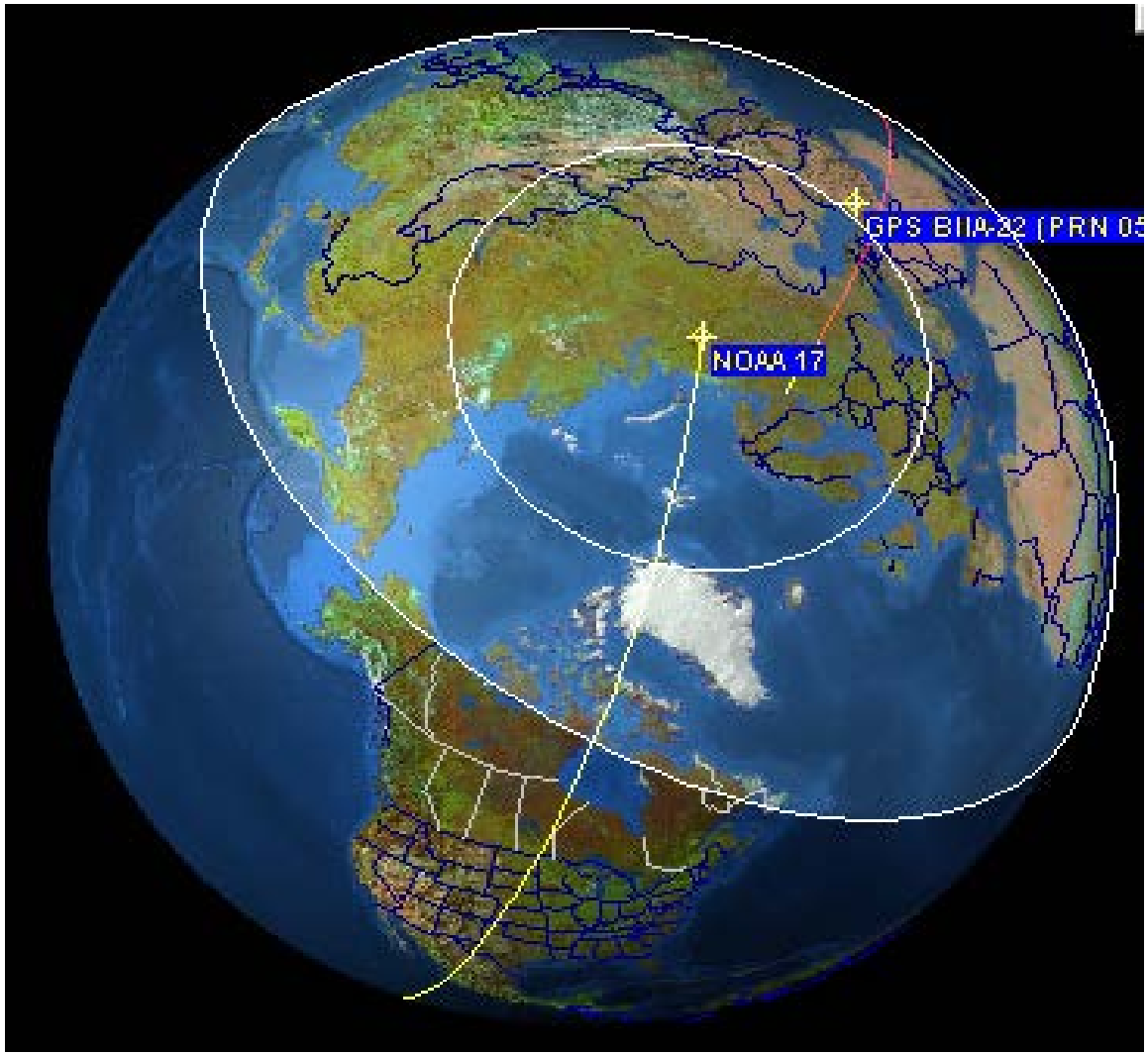
MEOSAR: AN IMPROVED SYSTEM CONCEPT

MEO sat at 20,000 km

LEO sat at 800-900 km



- MEO larger footprint than LEO
- Combines the best attributes of LEO and GEO
- Continuous global coverage (including poles)



LEOSAR vs. GEOSAR vs. MEOSAR

- LEOSAR
  - Small footprint
  - Limited satellites, hence wait times can be significant
  - On-board storage, global coverage is achieved
  - Independent locations via Doppler processing (need 3 or more bursts)

- GEOSAR
  - Large footprint
  - No coverage at the poles
  - Repeater only, geostationary, hence more susceptible to blockages
  - No independent location capability

- MEOSAR
  - Large footprint
  - Coverage at the poles
  - Repeater only, moving, slow orbit (blockages may occur)
  - Requires mutual visibility to 3 or more satellites for independent location
  - An independent location can be achieved on a single burst

US MEOSAR/MEOLUT COVERAGE PROFILE

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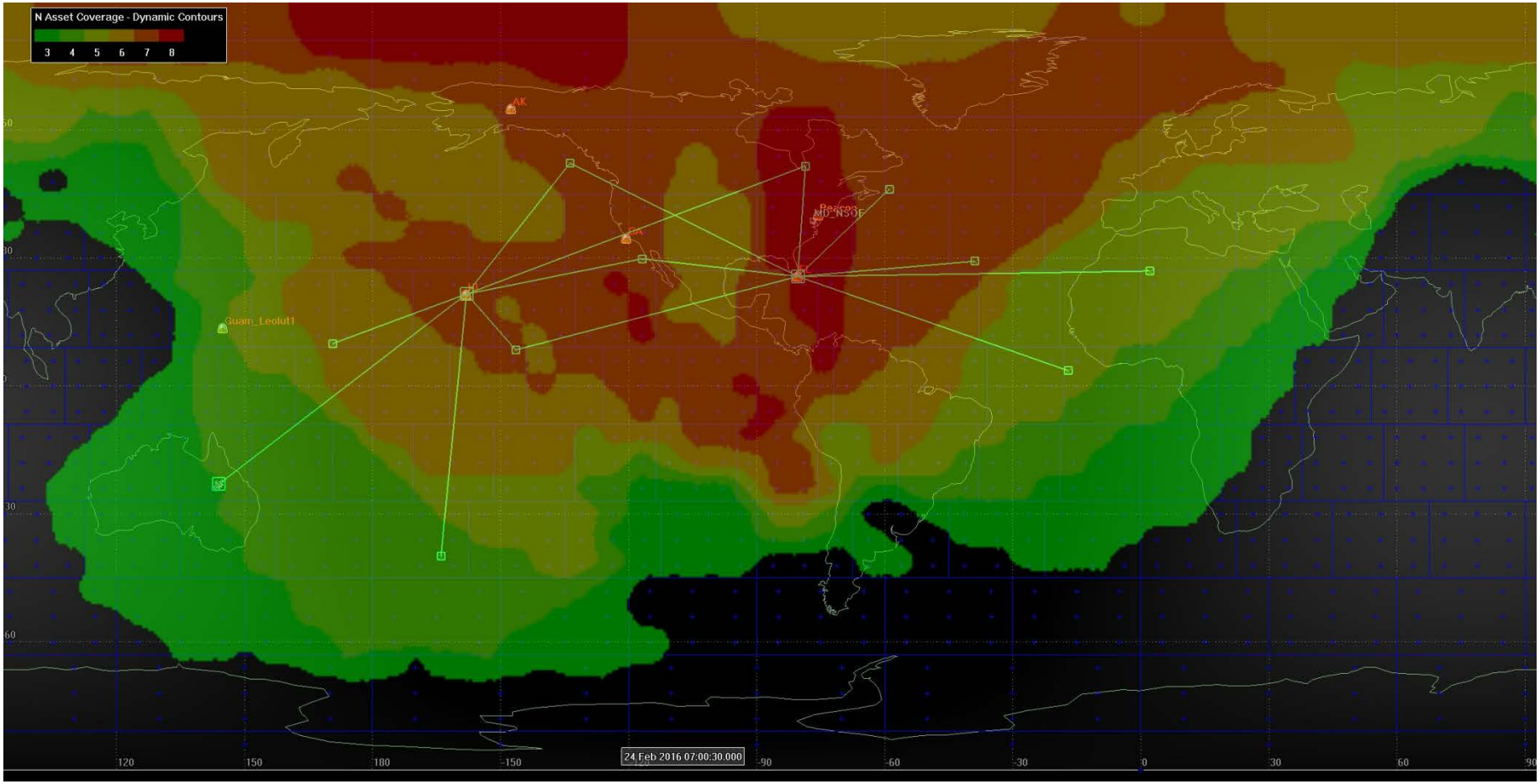

US MEOSAR/MEOLUT COVERAGE PROFILE

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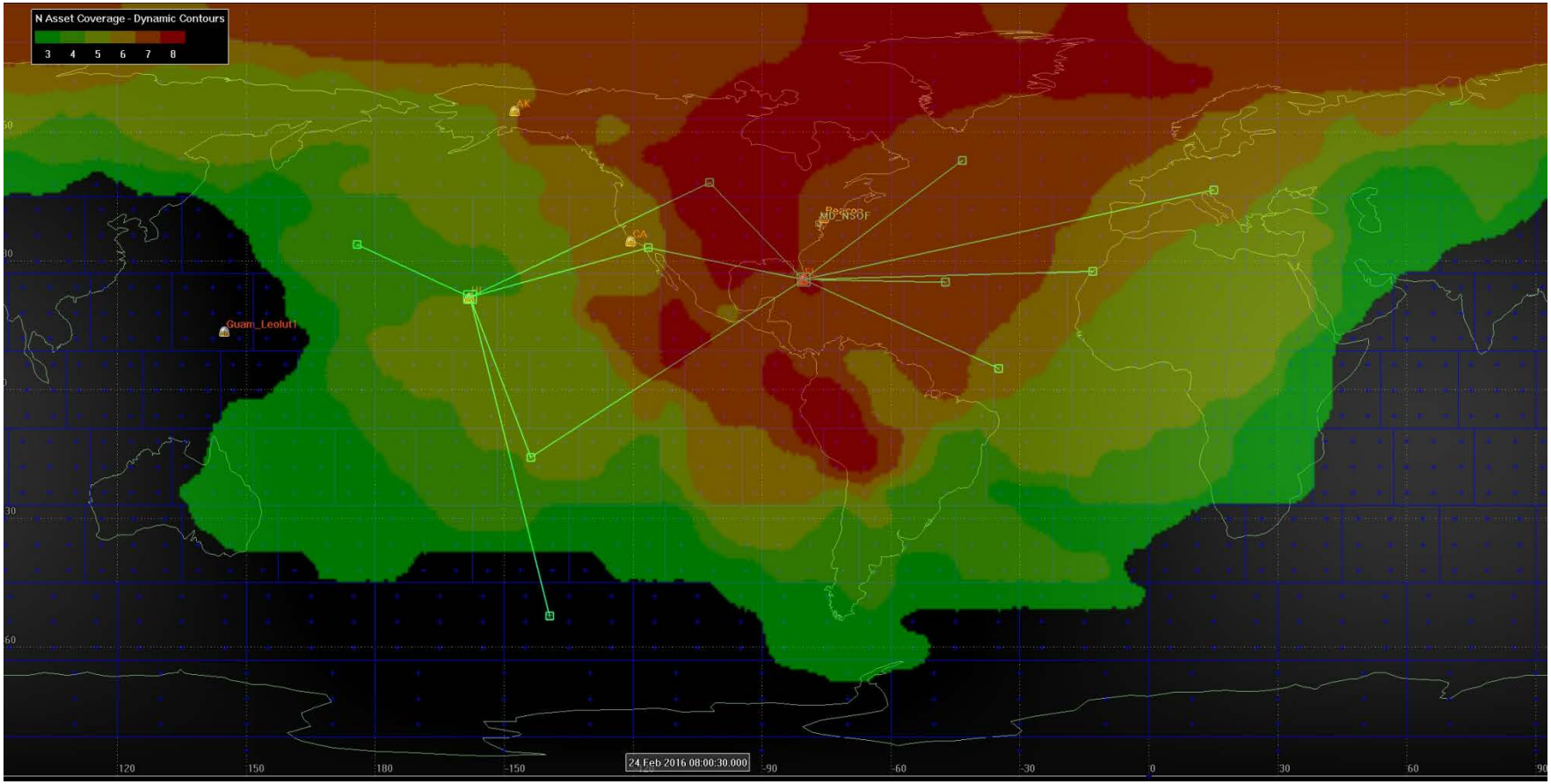

US MEOSAR/MEOLUT COVERAGE PROFILE

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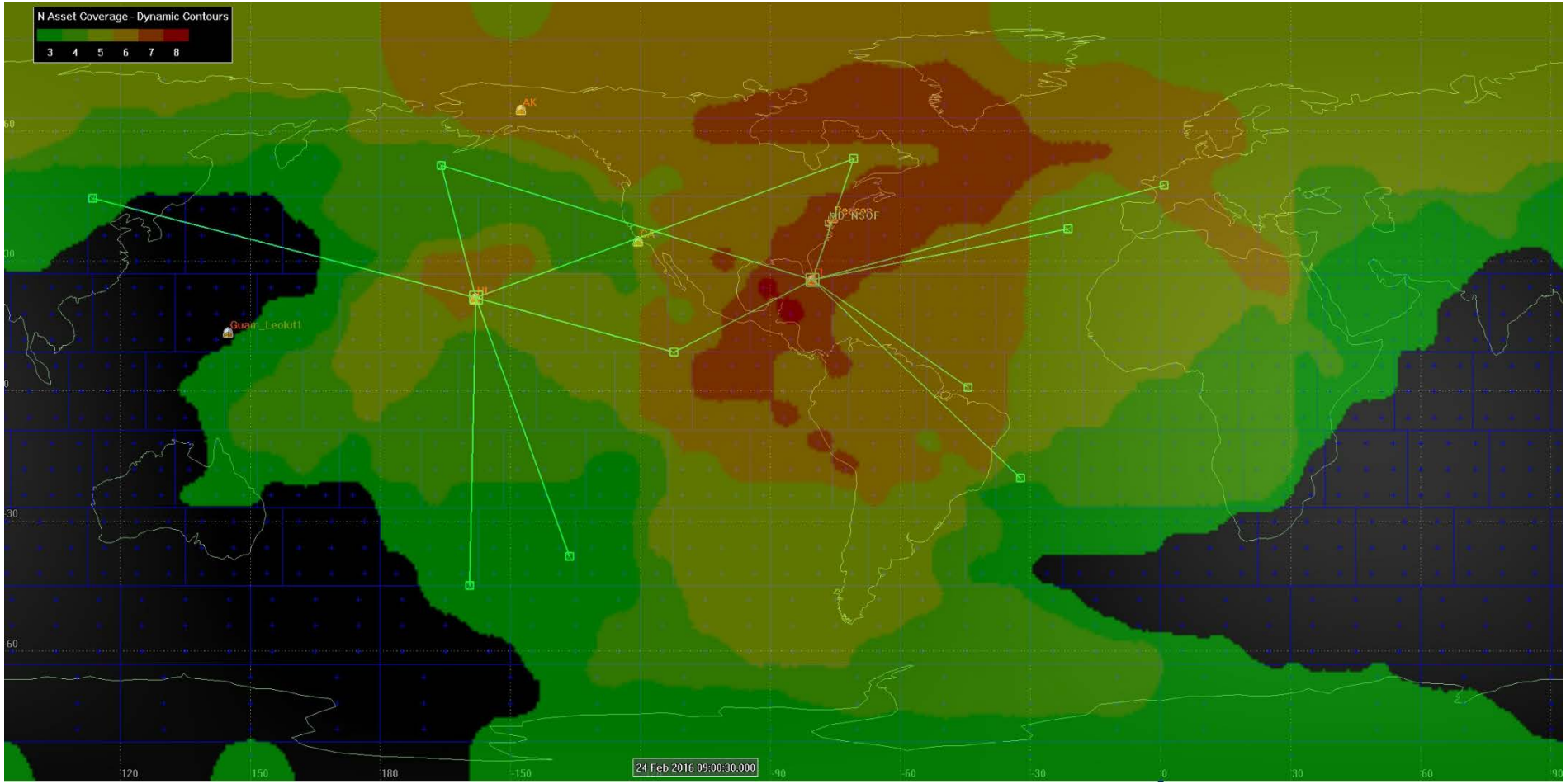

US MEOSAR/MEOLUT COVERAGE PROFILE

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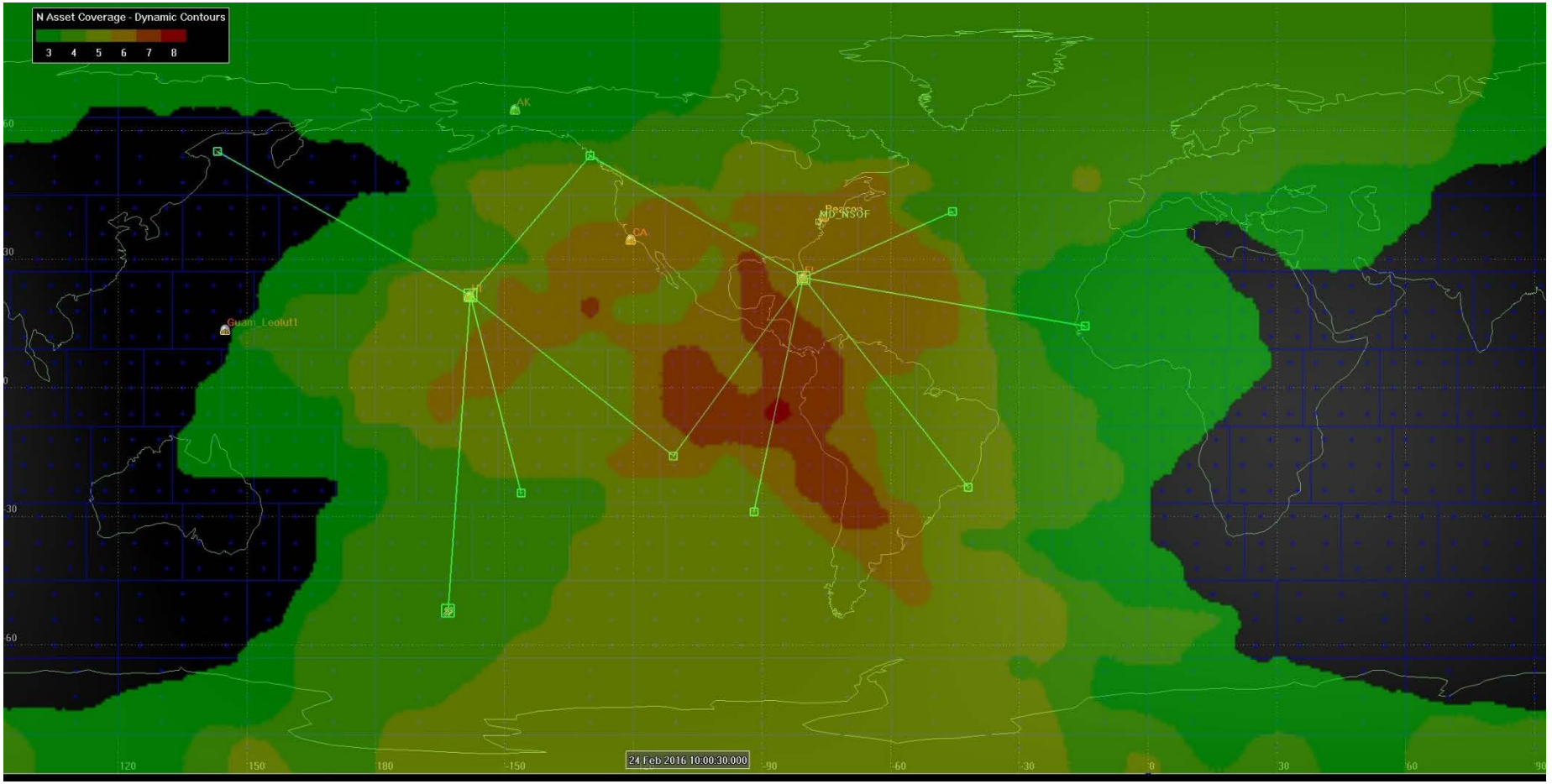

US MEOSAR/MEOLUT COVERAGE PROFILE

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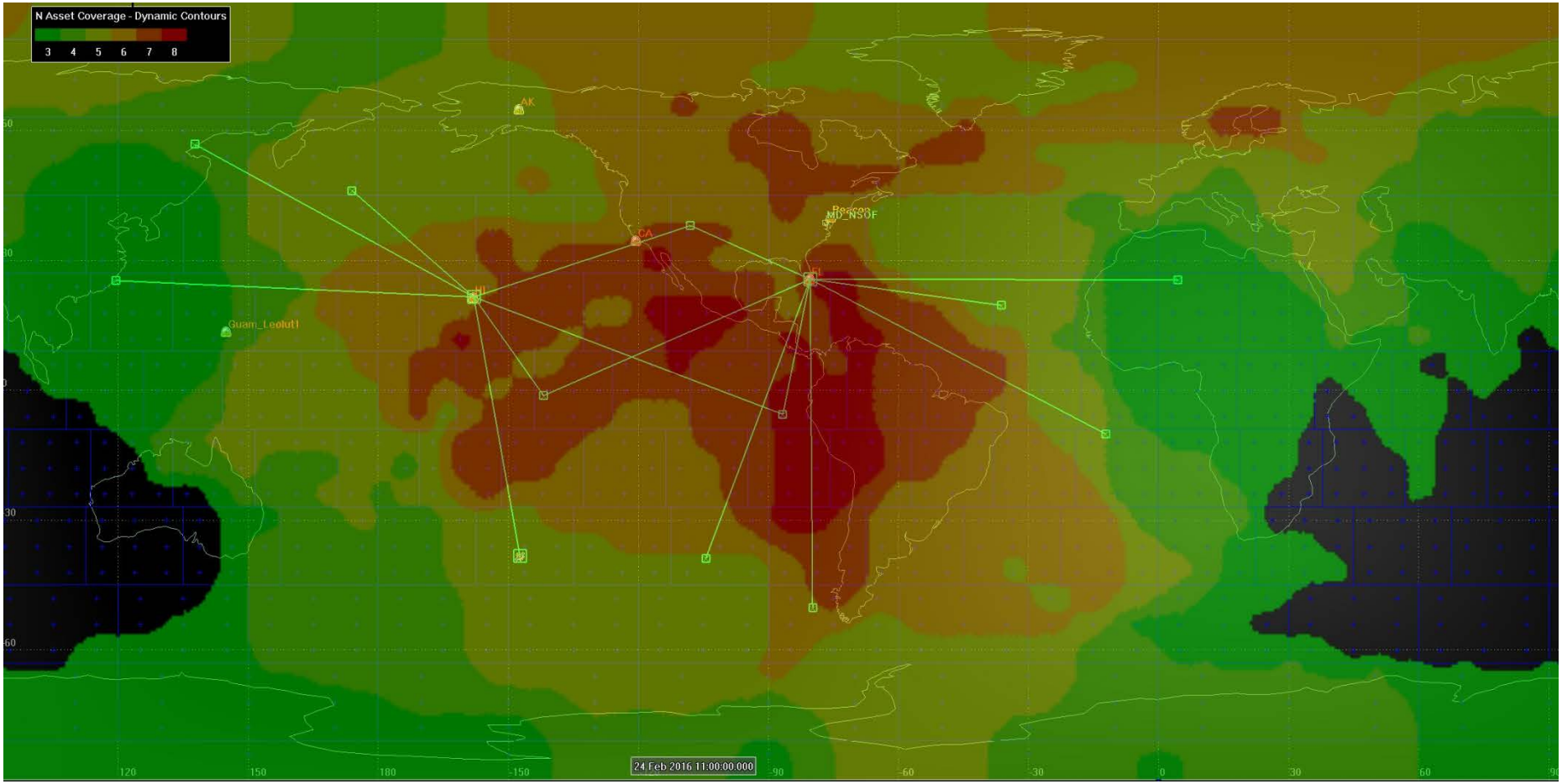

US MEOSAR/MEOLUT COVERAGE PROFILE

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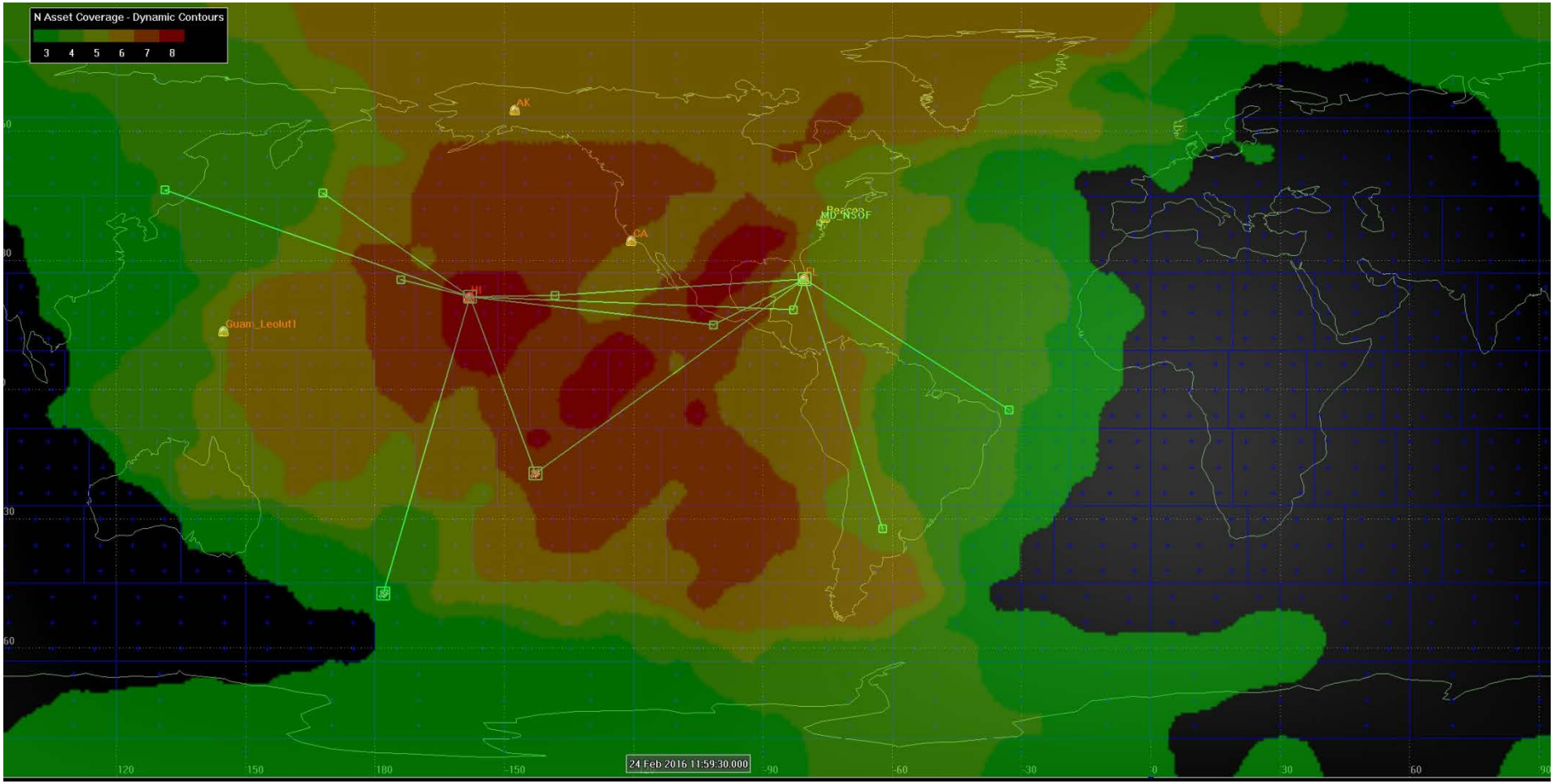


MEOSAR – Performance vs. LEO/GEO

- Evaluated 4 operational cases from Jan 14-17, 2016
- Both MEOLUTs (FL and HI) were in “stand-alone” (not networked) mode during the period
- Performance of “stand-alone” MEOLUTs was interlaced with LEO/GEO timeline on following slides
- Overall performance shows benefit of using MEOSAR data in combination with LEO/GEO
  - Added benefit of using data is reduced ambiguity resolution time
  - Overcomes “blockage effect” that possibly exists with GEO
  - Overcomes wait times for LEO passes over beacon
  - Performance for single burst is being refined
  - Multiple burst solutions using current DASS satellites being tested for EOC compliance
  - Throughput for DASS is lower than Galileo (65% vs. 90%) which is also expected on SAR/GPS

MEOSAR – Performance vs. LEO/GEO (cont.)

Jan 14, 2016 Cuba

On 14 January 2016 at 1527 UTC the COSPAS-SARSAT system detected a 406 MHz EPIRB at 21 18.4N 080 09.4W, 66 NM south west of Cuba. The EPIRB was manually activated when the S/V Marmouz became disabled due to engine problems, with two people on board. Coast Guard District 7 (CGD7) received the SARSAT alert and contacted the Aviation RCC (ARCC), after contacting Cuban authorities who stated they had no surface means to respond. With permission given by ARCC, CGD7 launched a HC-130 fixed wing aircraft that flew over Cuba and established communication with the vessel. CGD7 directed the vessel's crew to keep the EPIRB active for tracking until a Coast Guard vessel arrived on scene. The HC-130 broadcast a Marine Assistance Request Broadcast (MARB). CGD7 notified the Cuban Border Guard (CBG) that a US Coast Guard vessel was inside Cuban territorial waters, deployed their surface unit, established communication with the S/V Marmouz. The CBG towed the vessel to port.

<u>Case Evaluation notes</u> (FL MEOLUT 278 mi away-----HI MEOLUT 4900 mi away)

1. Encoded location beacon but Encoded vs. Ground Truth location is off from 13.3 to 11.8 km during first 30 minutes of case period. *Ground Truth questionable over time for drifting boat*.
2. First encoded location through FL MEO at 1531
3. First computed location through FL MEO at 1533,
4. First GEO encoded reported at 1534
5. At 1601, FL MEO computed location and encoded location were <1 km apart
6. First LEO computed doppler location (A & B) computed at 1607, encoded loc resolution resolved ambiguity

MEOSAR – Performance vs. LEO/GEO (cont.)

Jan 15, 2016 Hooper Bay, Alaska

On 15 January 2016 at 1925 UTC the COSPAS-SARSAT system detected a 406 MHz ELT at 61 27.7N, 166 10.5W, at Hooper Bay Airport, Alaska. The ELT was activated when a small plane landed off-runway due to damaged runway lights. The Alaska Rescue Coordination Center received the SARSAT alert and contacted the aircraft operator. No encoded location, airport was post test ground truth.

Case Evaluation notes (FL MEOLUT 4550 mi away-----HI MEOLUT 2850 mi away)

1. HI MEOLUT 2850 mi away computes location at 1925, within 3.87 km from GT.*
2. GEO detects unlocated alert 1925
3. Next two HI MEO computed locations at 1934 & 1935 have computed locations with larger errors from GT* but 1935 solution compares with 1925 solution and higher QF
4. First LEO computed location reported at 2327, verified at 2333
5. At 2334 FL MEO computed location and 5.95 km from GT
6. Note that stand-alone performance for HI MEOLUT was very good.

MEOSAR – Performance vs. LEO/GEO (cont.)

Jan 16, 2016 Breckenridge, Colorado

On 16 January 2016 at 2249 UTC the COSPAS-SARSAT system detected a 406 MHz PLB at 39 24.2N, 106 03.8W, approximately five miles south of Breckenridge, Colorado. The PLB was activated when a hiker became lost. The Air Force Rescue Coordination Center received the SARSAT alert and notified the Summit County, CO Sheriff's Office (SCSO) of the distress. The individual in distress was recovered by an SCSO rescue team and taken to a safe location.

Case Evaluation notes (FL MEOLUT 1750 mi away-----HI MEOLUT 3280 mi away)

1. GEO produces unlocated alert at 2249
2. FL MEO produces computed location at 2249, location error from reported GT*, 13.71km
3. Next FL MEO computed location at 2259 has computed location with 2 km error from GT.*
4. First LEO computed location reported at 2309, verified at 2333
5. At 2314 FL & HI MEOs report encoded locations <1km from GT
6. At 2317 first GEO encoded locations reported with 12 km errors
7. FL MEO performance in stand alone mode was good for this case.
8. HI MEO never computed a location for this case, only encoded locations.

MEOSAR – Performance vs. LEO/GEO (cont.)

Jan 17, 2016 Mt. Hood, Oregon

On 17 January 2016 at 0402 UTC the COSPAS-SARSAT system detected a 406 MHz PLB at 45 19.1N, 121 37.2W, near Mt. Hood, Oregon. The PLB was activated when an individual suffered a sprained ankle. The Air Force Rescue Coordination Center received the SARSAT alert and contacted the Oregon Joint Operations Center (OR JOC). The OR JOC dispatched Oregon State Police emergency responders to the location of the distress. The hiker was located and transported to a medical center for treatment.

Case Evaluation notes (FL MEOLUT 2650 mi away-----HI MEOLUT 2624 mi away)

1. HI MEO produces computed location <6km error and encoded location <0.5km from GT* at 0403
2. GEO reports encoded location <0.5km from GT at 0403
3. LEO reports computed location and encoded location at 0426
4. HI MEO performance in stand alone mode was good for this case as 10 minute.
5. FL MEO computed a location for this case, at 0458, but was a “blown solution”.
6. Next FL MEO computed solution was at 0531, 19 km error, needs further investigation, QF
7. FL MEO finally produces a computed solution at 0546 with 4.6km error

MEOSAR – Performance

El Faro incident

US SARSAT program engineering staff analyzed the data from the operational Low Earth Orbiting Search and Rescue (LEOSAR) and Geosynchronous Earth Orbiting Search and Rescue (GEOSAR) systems as well as the data received by the experimental (and still under Demonstration & Evaluation testing) Medium Earth Orbiting Search and Rescue system for the “El Faro” cargo ship incident that occurred on Oct. 1, 2015.

Reported position of the El Faro from AIS was 24.275N, 74.945W and the reported position from an Inmarsat beacon was 23.28N, 73.48W.

LEOSAR system had two satellites in view of the reported incident area from 1022-1047z and again at 1204-1224z on Oct. 1, 2015. These satellites, Sarsat-7 and Sarsat-10 are in almost identical orbit planes. The time period and detections from the GEOSAR system seem to confirm that the distress beacon was not transmitting when either LEOSAR satellite, S7 or S10, was in view of the incident area and communicating with the Florida LEOLUT

GEOSAR system detected un-located distress alerts via the GOES-13 (East) satellite & the MD-1 ground station. Detections from a beacon registered to the El Faro were received at 1136z and on an intermittent basis until 1158z on Oct. 1st.

These conditions did not allow for the current operational LEOSAR system to process/calculate a location for the distress beacon.

MEOSAR – Performance

El Faro incident

The US MEOSAR system consists of two (2) ground stations each comprised of 6 antennas.

One of these systems is located at the USCG Commsta Miami and the other is located at the USCG Commsta Honolulu.

These two systems are undergoing Demonstration & Evaluation, Phase II testing and their data was not being used operationally at the time of the incident.

The Florida MEOLUT had 3 antennas (out of 6) off-line for corrective maintenance at the time of the incident & networking between the Florida and Hawaii MEOLUTs was not enabled during the incident period.

The data retrieved from the MEO Mission Control Center (non-operational and under test) shows that the Florida MEOLUT received the distress beacon at 1136 through 2 of the 3 operating antennas from satellites 323 and 309.

The Hawaii MEOLUT also received the distress burst through 2 of its 6 antennas from two other satellites, 330 and 319.

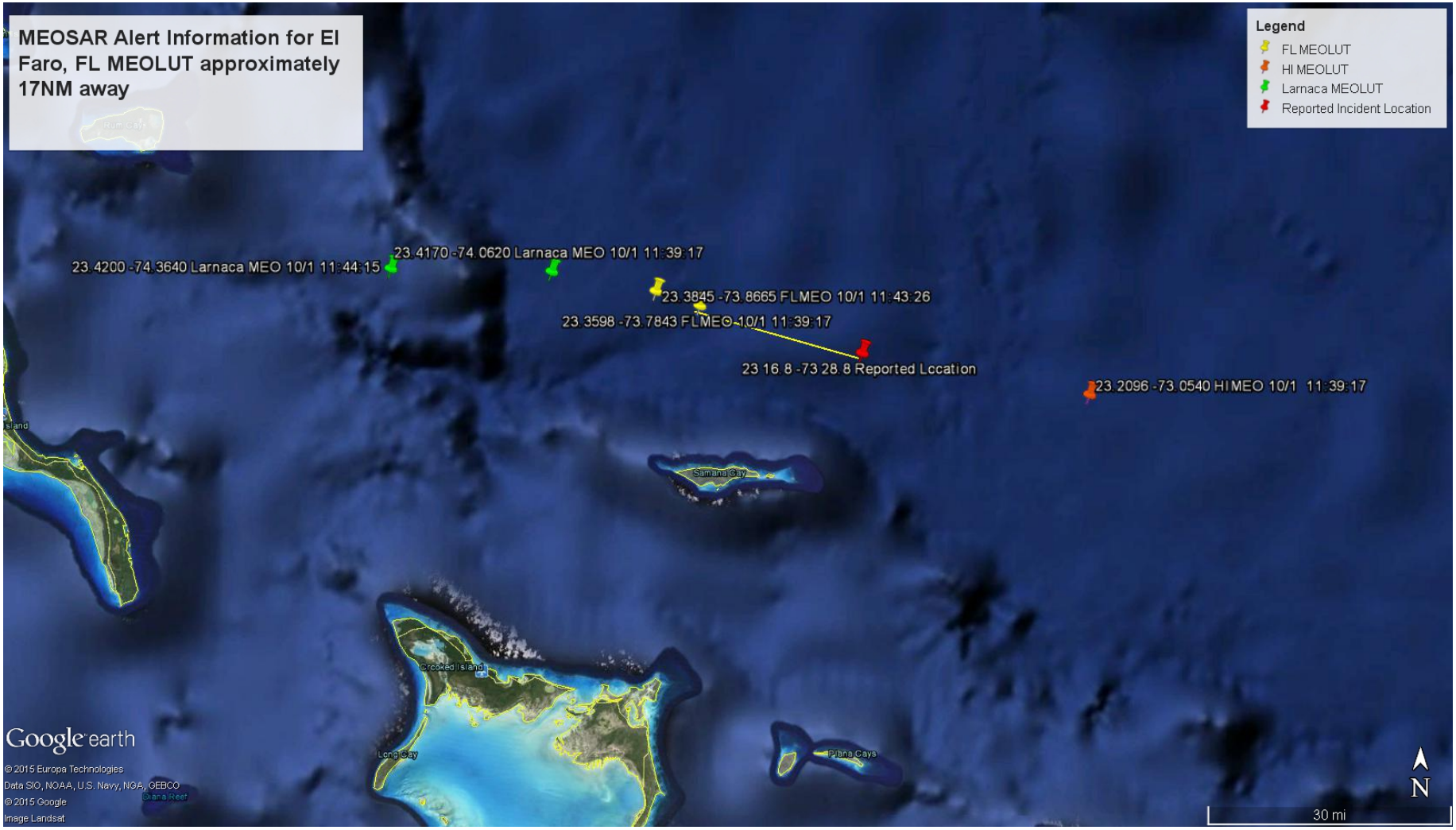
Had networking been enabled at the MEOMCC (a future planned operational configuration) a location would have been produced off the first detected burst at 1136z.

Since networking was not enabled during D&E testing, the first locations produced by the MEOLUTs in “stand-alone mode” were the Florida MEOLUT, the Cyprus MEOLUT, and the Hawaii MEOLUT at 1139z.

These locations were calculated and their times are noted in the diagram on the following page.
Note that the reported (**not confirmed**) distress location was about 900 miles from the Florida MEOLUT, which produced a location approximately 17nm away. With a calculated Dilution of Precision (DOP) of 9 due to satellite geometry, it can be reasonably estimated that with more than 3 antennas (either the rest of the Florida antennas or networked), the DOP would be reduced significantly. And the location accuracy proportionally better.

MEOSAR – Performance

El Faro incident computed and reported locations



MEOSAR – Performance vs. LEO/GEO

- Evaluation of the performance of the US MEOLUTs vs. the requirements for Early Operational Capability is continuing with an expectation to commission the FLA MEOLUT for operational use by April 2016 and the HI MEOLUT by May 2016

- In the meantime, if you, as a controller, have an interesting or “lack of information” case, send me the Site ID or the beacon ID and I will begin a MEO investigation into the event. I have done these requests for Australia, New Zealand, and Brazil to date, along with periodic reviews of weekly cases as was presented in this brief.

- My contact info is

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