RISK ASSESSMENT ON RUSSIAN NAVAL PRESENCE AT CEUTA

In the last years the Spanish government has allowed Russian Navy presence in Ceuta's harbour[1]. A country is sovereign to let access to its ports to those ships it sees fit, however, this collides directly about being within an alliance (e.g. NATO), that is in a tense situation with the country where those ships belong: Russia. Playing both sides, flaunting the Spanish commitment in the "Baltic Air Policy"[2], while allowing free harbour to the Russian Navy, is such a thing that is not only harmful to the international credibility, but (as we will prove in this article), has serious risks on defense.

General picture

Ceuta, autonomous city of the Kingdom of Spain, is placed at the southernmost point of the Strait of Gibraltar. It has a population of 84,263 inhabitants (2015) and has an important port, with a mouth 300 meters wide and 18 meters deep,oriented towards north. It owns an anchorage surface of 793.10 Ha. Its piers are mainly devoted to trade and logistics, and an oil pier as well. Due to its characteristics and position it is a port that easily could be used as a "dual infrastructure" (both civilian and military).

In the strategic framework, we have to bear in mind the tension between NATO and Russia due to the Ukraine conflict. Without analyzing it here, it's evident that the relations between the parts have dramatically worsened. Is in this context where the Spanish government ambiguous behaviour doesn't fit. As it has been remarked from in international think tanks[3], this is a source of concern for the Atlantic Alliance

The worst scenario hypothesis

We think that , consider future scenarios should not fear anyone. All serious countries do it in order to have options if those scenarios become real. Recently, the RAND Corporation did a complete study on a possible conflict between Russia and NATO in the Baltic. Within our limits, we will describe what could happen in the scenario of a catastrophic worsening of the Russian-NATO relations, in which some Russian naval unit berthed in Ceuta opened fire.

The first thing to do is to take a look on the map. Ceuta is a very near enclave to two places that host important military facilities: Gibraltar (United Kingdom) and Rota (Spain). The first one is only 28 km far, whilst the second one is 124 km far. **Gibraltar**, despite its small dimensions, usually

[1] 27-03-2016 - El País: "Ceuta, base de la flota rusa en el Estrecho"
: http://politica.elpais.com/politica/2016/03/26/actualidad/1459022294_947252.html

[2] 29-12-2014 - Ministerio de Defensa: *"Cuatro aviones 'Eurofighter' se incorporan a la misión de la OTAN de policía aérea en el Báltico"*
http://www.lamoncloa.gob.es/serviciosdeprensa/notasprensa/mde/Paginas/2014/291214eurofighterbaltico.aspx

[3] 10-09-2015 - The Heritage Foundation: *"U.S. Should Condemn Spain's Military Support to the Russian Navy"*
http://www.heritage.org/research/reports/2015/09/us-should-condemn-spains-military-support-to-the-russian-navy

hosts major naval units, not only the *Royal Navy* ones, but *US Navy* ships as well[4]. The last years, nuclear submarines of both navies have been seen moored there in their transits east or westward.

Rota's naval base is of a double importance. First, hosts the force projection units of the Spanish Navy: one LHD (L-61 *Juan Carlos I*) and two LPD (L-51 *Galicia* and L-52 *Castilla*). We should remember that these ships could be commissioned under the NATO direct command if required. The second element to highlight is the US air and naval facilities. The last years this base has made a comeback as a waypoint of the C-2 and C-17 strategic airlift planes, but also to host the BMD-capable Arleigh Burke-Class Aegis destroyers[5].

Having realized therefore the military value of both Gibraltar and Rota, let's describe the Russian naval units that had berthed in Ceuta and their underlying implications[6]. We give the name and, in brackets, the class and type of anti-ship cruise missiles (ASCM) that they carry, in NATO designations:

- **Destroyers**: *Severomorsk, vice-Admiral Kulakov, Admiral Levchenko* (*Udaloy I* Class - SS-N-14), *Admiral Chabanenko* (*Udaloy II* Class; SS-N-22).
- **Frigates**: *Yaroslav Mudry* and *Neustrashimyy* (Neustrashimyy class; SS-N-25)
- **Submarines**: *Alrosa* and *Novorossiysk* (Kilo class variant 877; SS-N-27)

We won't describe here those ships, because their general characteristics are easily accessible online. We are more interested on describing the capabilities of the ASCMs that they carry. We give both designations (Russian/NATO) in order to avoid confusion.

- **URPK-5 / SS-N-14[7]:** 90 km range, Mach 0.9 speed (300 m/s) and 90 kg warhead. This is an ASuW variant of a Soviet era anti-submarine missile. Being outmatched by more recent designs, it's still useful against non AAW armed or unaware ships.
- **3M80 3M80 MVE / SS-N-22[8]:** 120 km-140 km range (MVE) d'abast, Mach 2.2 (748 m/s) at very low altitude (10-20 m over the sea). The "Moskit", as it's called in Russia, was designed to overwhelm the US Aegis ships response time, in high speed concept. We should remember that, in the best of the scenarios (detecting the missile from its very

[4] Íbid: *"This is especially true for the U.S. Navy's nuclear-powered submarines. Gibraltar is the best place in the Mediterranean Sea to repair and resupply U.S. submarines. Strong U.S.–U.K. military cooperation assists the U.S. in keeping its submarine assets integrated into the European theater."*

[5] Admiral James G. Stavridis, *testimony before the Committee on Armed Services*, U.S. Senate, March 1, 2012, http://aco.nato.int/resources/site631/saceur/documents/stavridis_sasc.pdf pp. 74-75: "*Stationing four U.S. Navy Aegis Ballistic Missile Defense destroyers in Rota, Spain. This effort directly supports the President's European Phased Adaptive Approach (EPAA) to Missile Defense. EPAA outlines the phased implementation of U.S. contributions to an allied missile defense capability for Europe that protects U.S. forces stationed in Europe, our allies and partners, and the U.S. homeland. In terms of this mission, forward-based forces provide considerable efficiency when compared to the force generation required to meet the same requirement with rotational U.S. forces. The Navy estimates that it would take 20 ships based in the United States to supply the presence provided by these four forward-deployed ships."*

[6] A list of the ships berthed in Ceuta: Luke Coffey, "*Russian Navy's Use of Ceuta as a Provisioning Base, 2011 to August 2015,"* The Heritage Foundation http://thf_media.s3.amazonaws.com/2015/pdf/RussianNavyCeutaVisits.pdf

[7] See: http://kollektsiya.ru/raketi/320-urk-5-rastrub-b-universalnyj-raketnyj-kompleks.html

[8] See: https://fas.org/man/dod-101/sys/missile/row/moskit.htm

launch), the target has less than three minutes to respond. Despite the 300 kg of warhead mentioned, only half of this weight is explosive, being an armour piercing warhead.

- **3M24 / SS-N-25[9]:** 130 km range, Mach 0.9 speed (300 m/s). Despite being a sub-sonic ASCM, the great advantage of this missile is its ability to keep an extremely low flight (3-5 m), due to its high precision radio-altimeter. It carries a 150 kg warhead.
- **3M-54E / SS-N-27[10]:** 220 km range, Mach 0.6-0.8 cruise speed (200-270 m/s) and Mach 2.9 (990 m/s) in the target approach final stage (last 60 km). This ASCM belongs to the "Klub" missiles family, being this the submarine-launched one and low flying altitude (10-15 m). In addition to the super-sonic speed in the final approach, the Klub is a missile with a 200 kg warhead.

Described the general missiles' characteristics, we should calculate the its flight times from Ceuta to Gibraltar and Rota

Missile	Ceuta - Gibraltar 28 km	Ceuta - Rota 124 km
SS-N-14	1 min : 33.3 s	Out of range
SS-N-22	37.4 s	2 min : 45.8 s
SS-N-25	1 min : 33.3 s	6 min : 53.3 s
SS-N-27	24.2 s	5 min : 51.2 s

We can see that, in a sudden outbreak of hostilities between Russia and NATO, if any Russian naval unit were placed at Ceuta, the NATO units in Gibraltar will have less than a minute and half to react. For Rota we found a margin of less than three minutes for the SS-N-22 and almost 7 for the SS-N-25. We have to bear in mind that the last ones have a smaller radar cross-section, being harder to detect despite slower than the other ones. Anyway, as in combat lots of factors play at the same time, we will try to combine those in order to produce tactical hypothesis.

Methodology

We are to use the salvo model equations designed by Captain Wayne P. Hughes (US Navy, Ret.)[11]. In this study, we use the simple version of the equation, that depicts two fleets (A and B), where the following factors are combined[12]:

- ***Staying power:*** the number of hits needed to put a ship out of action (OOA), symbolized by a_1 and b_1 respectively.

[9] See: https://fas.org/man/dod-101/sys/missile/row/as-20.htm
[10] See: https://fas.org/man/dod-101/sys/missile/row/club.htm
[11] Capt. Hughes, Wayne P. "Fleet tactics and Coastal Combat, 2nd Edition"; US Naval Institute Press, 2000
[12] Op.Cit. pp.268-270

- ***Salvo size:*** number of ASCMs launched for every fleet. In the equation, however, this factor doesn't appear so only a fraction of the missiles will rightly acquire the target[13].
- ***Striking power****:* the number of "good shots", in other words, the quantity of missiles that would hit the enemy fleet if these were undefended, represented by α and β respectively.
- ***Defensive power****:* number of missiles ("good shots") that the attacked ship or fleet can destroy or deflect[14] when on alert and ready[15]. Are represented by a_3 and b_3 respectively. (The ships survivality is the combination of both staying power and defensive power)

The equations will give the number of enemy ships ΔA o ΔB put out of action (OOA) in a single salvo. Therefore, to find out how many ships can put OOA the fleet A we will have this formula:

$$\Delta B = (\alpha A - b_3 B)/b_1 B$$

Take a practical example to clarify. Imagine that the fleet A is composed by 2 ships that launch a salvo of which obtains 3 "good shots" for every ship. The target, fleet B, has also 2 ships with a defensive power of 1 for ship, and the same number for the staying power. The equation will be so ΔB =(3x2-2x2)/2x1= 1 . Therefore, we see that the fleet A has put OOA one of the ships of the fleet B. Can be interpreted as the SAM, CIWS, jammers and decoys of the fleet B have been insufficient.

In order to make easier the reading, we describe the calculus that we have made in an appendix at the documents end. Let's move now to the scenarios.

Scenarios

As we have already said, the object of this study is to depict the different tactical possibilities in a strategic framework in a conflict outbreak between Russia and NATO. Despite such an scenario may seem hard to imagine, with Russian warships moored in a NATO port, we have to remember that from the WWII on, Moscow has unleashed decisive actions without awereness of the preparations by its adversaries[16]. Is not in vain that the term "maskirovka"[17], echoes through the times.

The surprise element could play an important role. Due that we will get two possible results, with the total defensive force of each ship in one hand, and another one with a 0.5 coefficient. The surprise element has been decisive in several episodes of the military History and, the naval actions, are not an exception. The Batle of the Nile, or Aboukir Bay, (1798), Taranto (1940), or Pearl Harbour (1941) are good examples of how fleets equal or superior to the attacking ones are

[13] This error margin could be due to factors as an incorrect firing solution. Remember that the sensors never are 100% reliable, and crews don't react the same way in exercises as in a real combat environment.
[14] Hughes refers to SAMs and CIWS and jammers and decoys as well.
[15] Remember that the surprise has influence in the outcome. There would not be the same possibilities to respond to an attack if the sensors detect the missiles at the very launching moment (and "battle stations" have been ordered), for example, as if these missiles are detected in the final approaching stage.
[16] Lloyd, Mark. *"The art of military deception";*Pen and Sword, 1997. See chapter V: "*Maskirovka; a powerful Soviet concept"* pp 115-137
[17] Maskirovka: a hard to define word (and that's precisely that the Russian term is often used directly), that refers to the action of hiding the own intent to the enemy by an array of deception and confusing actions.

put out of action without option to respond effectively. Due to different reasons, Frenchs, Italians and Americans were not in the alert situation that they must, and were severely defeated.

So let's start, with the scenario of a launching from Ceuta to Gibraltar. Remember that the distance is 28 km and there are no geographical obstacles in the trajectory. In this case, we will count all the Russian missiles as "good shots", due to it's easy to obtain a good firing solution. In the first simulation the target is a nuclear-powered attack submarine (SSN); we've not specified the class, so it hasn't importance in this scenario. It could be either a British *Astute* or an American *Los Angeles* SSN as well. We've added a defensive force equal to 3 to the SSN because, despite these ships have no AAW systems could count with the MANPADS of the Royal Gibraltar Regiment. In this situation there's only one Russian naval unit, an Udaloy II class destroyer.

	ASCM (nº)	Numerical result	Interpretation
Udaloy II vs SSN	SS-N-22 (8)	5	SSN OOA – 4 ASCM abound
Udaloy II vs SSN (low alert)	SS-N-22 (8)	6.5	SSN OOA – 5 ASCM abound

We can see so, that in both simulations the submarine berthed at Gibraltar ends out of action and some missiles of the salvo still remain. As how programmed those missiles are, could keep hitting the neutralized target or search for other ships nearby.

Let's simulate what could happen if a British **Type 45 "Daring" class destroyer**[18] were berthed at Gibraltar. These are a class of ships designed with the Falklands War experiences in mind, to provide defence against massive ASCM attacks. They carry 6 VLS Sylver modules, with 8 launch cells each one. This system provides a rate of fire of 8 missiles in 10 seconds, but in extreme situations 6 missiles per second could be launched.

	ASCM (nº)	Numerical result	Interpretation
Udaloy II vs *Type 45*	SS-N-22 (8)	-9.8	*Type 45* survives undamaged
Udaloy II vs *Type 45* (low alert)	SS-N-22 (8)	-2.32	*Type 45* survives undamaged

In both situations the destroyer succeeds in shooting down the ASMCs. A predictable outcome being those types of warships designed to perform this very task. It could be logically so, that the Russian ships moored in Ceuta would refrain to attack these destroyers, even less when if its elimination would not be worth benefit like degrade the NATO naval BMD capability.

It's the turn to analyze the probabilities in the scenario of an ASCMs launch to the naval base of Rota. As we have already said, the distance from the launching point to the target is 124 km long. If we take a look on the map, there's a low mountain zone. Bearing in mind that the formerly

[18] See http://www.naval-technology.com/projects/horizon/

described missiles have very low flying patterns, this poses an obstacle to the radars of the warships moored at Rota. Due to, during the first 40 km of flight of the ASCMs would be virtually impossible to obtain a firing solution to shoot them down. For this reason in the simulations we will shorten the distance from which the NATO ships can obtain a fire solution to 84 km.

The first of the tactical situations that we will simulate is an attack on the strategic projection units of the Spanish Navy; more specifically, the ***Juan Carlos I*** LHD. Despite this ship only have 20 mm guns as CIWS, we have incorporated a *Santa Maria* class[19] frigate into the calculus. Rota is also the home port of the Spanish Navy 41st Escort Squadron, that sums up 6 ships of this class. Despite the defence budget cuts and the shrinking readiness levels, we believe that at least one of the frigates would be ready to fight. These ships have a missile launcher Mk.13, with a rate of fire of 1 missile every 10 seconds[20].

	ASCM (nº)	Numerical result	Interpretation
Udaloy II vs *Juan Carlos I*	SS-N-22 (8)	-0,8	*Juan Carlos I* survives undammaged
Udaloy II vs *Juan Carlos I* (low alert)	SS-N-22 (8)	0,6	*Juan Carlos I* seriously damaged

The outcome so, is that in a situation of tactical surprise a single salvo could let seriously damaged the flagship of the Spanish Navy. Remember that with such damage (60%), major reparation works should be done, and it equals that this ship will remain out of action in a short campaign scenario.

Let's have a look at what could happen if the attack was made with SS-N-25 missiles. We've already noted its ability to flight at extremely low altitude. This will let, with a skimming flight between 3-5 meters high, to "jump" just afterwards the mountain zone of the La Janda county, only 27 km away from Rota. If in a scenario as the September 14th of 2012, when two *Neustrashimyy* frigates were berthed in Ceuta, this will be equal to a 16 missiles salvo[21].

	ASCM (nº)	Numerical result	Interpretation
Neustrashimyy (2) vs *Juan Carlos I*	SS-N-25 (16)	1.75	*Juan Carlos I* OOA
Neustrashimyy (2) vs *Juan Carlos I* (low alert)	SS-N-25 (16)	2.87	*Juan Carlos I* OOA – 2-3 ASCM abound

[19] This was the name adopted by the Spanish variant od the American frigate *Oliver Hazard Perry*. See: http://www.naval-technology.com/projects/oliver-hazard/

[20] See: www.alternatewars.com/BBOW/Weapons/US_GMLS.htm

[21] See: Luke Coffey, "Russian Navy's Use of Ceuta as a Provisioning Base, 2011 to August 2015," The Heritage Foundation http://thf_media.s3.amazonaws.com/2015/pdf/RussianNavyCeutaVisits.pd

In this simulation, we can see that in both hypotheses the amphibious assault ship is put out of action. In the second one, between 2 and 3 missiles could acquire near staying targets. The LPDs *Galicia* and *Castilla* usually berth nearby.

Let's depict now that the attack was to the NATO naval BMD present at Rota, with the American destroyers of the *Arleigh Burke* class. This, as the British *Daring* class, was designed to provide protection against saturation attacks with ASCMs. They have a pair of Mk.41[22] systems with 48 VLS cells each. They can reach a rate of fire of 1 missile per second[23].

	ASCM (nº)	Numerical result	Interpretation
Udaloy II vs *Arleigh Burke* DDG	SS-N-22 (8)	-72	*Arleigh Burke* DDG survives undamaged
Udaloy II vs *Arleigh Burke* DDG (low alert)	SS-N-22 (8)	-35	*Arleigh Burke* DDG survives undamaged

	ASCM (nº)	Numerical result	Interpretation
Neustrashimyy (2) vs *Arleigh Burke* DDG	SS-N-25 (16)	-55	*Arleigh Burke* DDG survives undamaged
Neustrashimyy (2) vs *Arleigh Burke* DDG (low alert)	SS-N-25 (16)	-25	*Arleigh Burke* DDG survives undamaged

It's self-evident, so, that to attack an Aegis ship with two Mk.41 launchers with only 8 or 16 ASCMs is not enough to sink it. Despite predictable without this simulation, it's worth to do to predict the kind of actions to carry out by Russia to neutralize the NATO naval BMD. As we said before, these actions would be part of a bigger scenario. A possible option could be a coordinated multilateral launch Time-on-Target (TOT). One of the launching points could be Ceuta, whilst another one could be some point on the international waters south of Rota. This way, a couple of submarines of the *Kilo* class could launch a dozen of Klub missiles. Doing that at a distance less than 60 km (from which them fly at Mach 2.9), the NATO warships would have less than a minute to respond; and this with the missiles launched from Ceuta inbound. We should not discard a launch from strategic bombers. It can be objected that these bombers could be monitored while their course trough the Atlantic, but it will not be the first time that the Russian Air Force surprise. For example, in 2000 the US carrier *Kitty Hawk* and her escort group were victim of a mock attack[24] by Russian warplanes (those planes were not detected till the last moment); have been a real attack, it's feasible that the *Kitty Hawk* had had no time to react.

[22] See: http://www.alternatewars.com/BBOW/Weapons/VLS_Baselines.pdf
[23] See: http://www.alternatewars.com/BBOW/Weapons/US_GMLS.htm
[24] Thompson, Roger; Tompson, Roger; *"Lessons Not learned: The U.S. Navy's Status Quo Culture"* US Naval Institute Press, 2007 pp.81-84

CONCLUSIONS

As we have tried to prove in this study, the risk for the NATO exists. From the beginning, we have said that is an extreme scenario, however, that's not an exemption to neglect the analysis[25]. Being either only launching from Ceuta or teaming up with other naval and air units, Russia could neutralize the NATO naval forces at Gibraltar and Ceuta. This last case is especially serious, so hosts part of the Allied naval BMD.

Of course, Spain is free to undertake the policy of alliances it considers most appropriate. However, must define its position in the international arena, so, as we have already seen, the ambiguity could lead to serious risks. Either for whom who the Spanish government says that are its allies or its own forces. What has more weight, the Ceuta's "leisure" business in one hand, or the ballistic missile defence and the life of the Spanish military personnel? We must also take note of this in Catalonia.

[25] 8-4-2016 Stars and Stripes : "*Russian missiles prompt Navy to look at ships' close-in defenses"* http://www.stripes.com/news/russian-missiles-prompt-navy-to-look-at-ships-close-in-defenses-1.403477 *"But when engineers working aboard the Spain-based destroyer USS Porter installed a missile-launcher that can autonomously track and destroy incoming anti-ship missiles earlier this year, it was an acknowledgment of a shift in this theater: For the first time in post-Cold War Europe, the Navy must account for an adversary capable of threatening its ships with modern weapons — Russia. The Naples-based U.S. 6th Fleet made an urgent request last year to acquire the missile-launcher, the SeaRAM Close-In Weapon System, for installation on the Porter and three other destroyers based in Rota, Spain. Their concern is the advanced anti-ship cruise missiles being installed by Russia on its surface ships, aircraft, submarines and coastal defense sites."*

Methodology and computing

As we've said, we used the basic formula of salvo equations designed by the captain Wayne P. Hughes[26] (USN ret.):

$$\Delta B = (\alpha A - b_3 B)/b_1 B$$

More complex[27] formulas have been developed afterwards, but using this one as starting point[28].

In this study, we have used some coefficients to depict different outcomes of the tactical situation. Here we describe, factor by factor, some of the methodological problems that can be found and how we have tried to solve in the most accurate way.

Striking power: this factor is composed of the number of shots multiplied by the impact probability. As in this study we have posed a surprise attack, we have not applied the coefficient.

Defensive power: number of ASCMs eliminated. We have applied a 0.5 coefficient to pose a bigger tactical surprise. Can be interpreted as the order of "battle stations" has not been issued to the crew. In the other hand, in this simulation all the SAMs launched impact to their targets, however, in a a real combat scenario that could be very different.

Staying power: this is one of the hardest elements to compute so, if we suppose that a single missile value is 1, how many are needed to put a ship out of action? During the Falklands War (1982), the destroyer HMS *Sheffield* (D80) was sunk with a single *Exocet* ASCM. Taking as a reference one missile for every 5,000 tons a fraction could be applied with the displacement of every class of ship. However, this is troublesome due to several reasons. First, which is the level of the ship's compartmentalization? A ship built with the lessons learned in the Falklands War will try to increase it as much as possible. How is configured the ship internally? An amphibious ship has great internal spaces. So, if hit by a single missile the blast's consequences will be greater than in a destroyer, despite this ship has a lower displacement. Has the ship redundant systems? If with a single impact the power system is disabled, it's of few help that the ship can hold three.

We have to think about the different types of ASCMs that appear in this study. The Russian ships that have berthed in Ceuta till now carry 4 different types. In order to compute their power, we can use its warhead. So, the **SS-N-22** and **SS-N-25,** with a 150 kg warhead (very similar to the French *Exocet*), will have a **coefficient of 1**. The **SS-N-14**, with a 90 kg warhead, can be computed with a **0.6 coefficient**, while the **SS-N-25**, with a 200 kg warhead, would have a **1.33 coefficient**.

Bearing all this in mind, let's expose de computing tables with the nominal values for every ship:

[26] For a comprehensive summary: 29-9-2013 - Warship Pilosphy: *"The Salvo Model"* https://warshipphilosophy.wordpress.com/2013/09/29/the-salvo-model/

[27] Captain Hughes revised his own model in the second edition of "Fleet tactics". See:: 01-09-2005: "*The Salvo Equations: Tests and Applications*" http://www.dtic.mil/dtic/tr/fulltext/u2/a447950.pdf

[28] Seet Yao Ming Tiah: "*AN ANALYSIS OF SMALL NAVY TACTICS USING A MODIFIED HUGHES' SALVO MODEL"*, US Naval Postgraduate School, 2007http://www.dtic.mil/dtic/tr/fulltext/u2/a467282.pdf

Ship	Defensive power	Staying power
SSN	3*	1
Type 45 DDG	1 SAM/s	3
LHD *Juan Carlos I*	1 SAM/10 s**	4
Arleigh Burke class DDG	2 SAM/s	3

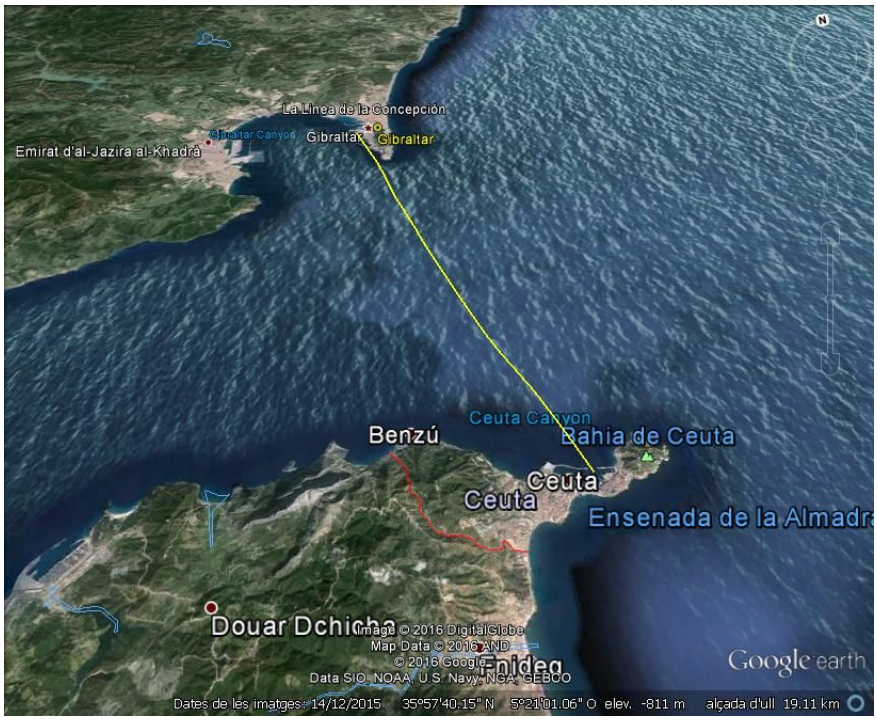
* Remember that, despite the sumbarines hasn't its own SAMs, this value has been applied to compute the MANPADS of the Royal Gibraltar Regiment

** With the Juan Carlos I, we have computed that could have the support of one of the Santa Maria class frigates, fitted with one Mk.14 launcher

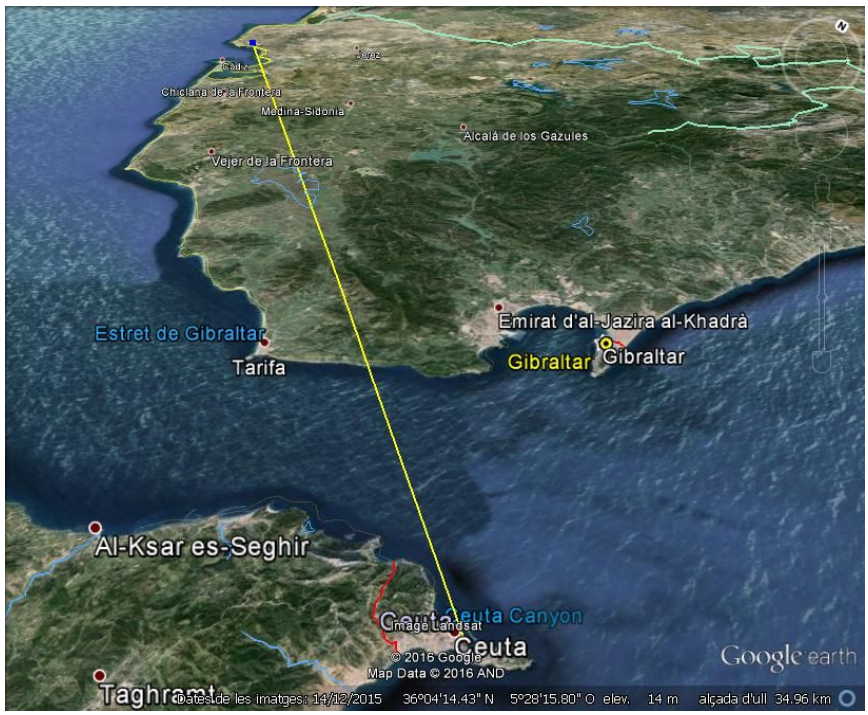
Ship	Salvo size	Missile type
Udaloy I class DD	8	SS-N-14
Udaloy II class DD	8	SS-N-22
Neustrashimyy class FFG	8	SS-N-25
Kilo class SSK	6	SS-N-27

Finally, we want to note the difficulty to detect the present ASCM. This ability to approach stealthily taking advantage of the topography elements continues to pose a serious problem[29]. Due that in some of the equations we have shortened some of the detection ranges.

[29] MacGregor, Douglas; *Transformation under fire: Revolutionizing how America fights*; Praeger, 2003 p.275 : "*Defensive systems must cover vast amounts of airspace, and stealthy, low-altitude cruise missiles can take advantage of certain terrain masking shorts lines of sight to avoid all but the most sophisticated air-defense detection and tracking networks. As potential adversaries learn to exploit global positioning systems for precision navigation; develop or buy small, highly efficient turbofan engines; and develop terminal guidance capabilities, cruise missiles will become more plentiful and dangerous."*



Possible course of the ASCM from Ceuta to Gibraltar. Source: Google Earth



Possible course of the ASMC from Ceuta to Rota. Source: Google Earth

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