N° 01/2012

recherches & documents

February 2012

Long Range Strikes in 2025

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www.frstrategie.org

FONDATION *pour la* RECHERCHE STRATÉGIQUE

Édité et diffusé par la Fondation pour la Recherche Stratégique
4 bis rue des Pâtures – 75016 PARIS

ISSN : 1966-5156
ISBN : 978-2-911101-66-3
EAN : 9782911101663

SOMMAIRE

Introduction

Deep strike can be defined as: "armed operations undertaken to neutralise or destroy targets that may be fixed or mobile, personnel or facilities, military or civil beyond the reach of conventional military units". This definition does not exclude recourse to special military units undertaking operations in enemy territory. Nevertheless, in this report, we consider the possibility of reaching a target several hundred kilometres behind the zone of direct contact between allied armed forces and those of the enemy. We therefore necessarily exclude those operations conducted at this level which could be considered as fire support operations or those contributing to air defence suppression missions.

Against this background, the airborne campaign against Libya seems to have demonstrated yet again the value of possessing and using cruise missiles in the first hours of conventional conflict, whether to neutralise enemy air defences, destroy infrastructure and strategic assets or attack political targets.

With 199 Tomahawk missiles used within just a few hours in the early days of the conflict[1], to which should be added the SCALP and STORM SHADOW missiles used by the French and British air forces, US forces confirmed the role of cruise missiles in the approach taken to the initial phases of the conflict by providing early-stage support for other precision strike assets. The volume used - within an almost identical timeframe - is however slightly higher than that for the early days of *Operation Enduring Freedom* (OEF), when the US Navy fired around a hundred TLAM Block III missiles. The main reason for this difference was the greater number of targets to be neutralised in the case of Libya.

It should be underlined at this point that there is, in principle, no currently-envisageable circumstance under which cruise missiles could replace conventional strike capability: the cost of acquisition and possession of cruise missiles is still too high to permit deployment in volumes comparable to those of other, much less costly, precision strike assets, such as laser-guided bombs[2]. The number of guided systems other than cruise missiles held in western arsenals demonstrate this fact, as does the ratio of usage between the two types of system in the case of - for example, but not exclusively - Libya: of the 8,000+ guided munitions used, only a few hundred were cruise missiles.

Recent examples of deep strike in action illustrate, albeit incompletely, the variety of situations and scenarios in which this type of military asset may be used.

Other than specific usage in the initial phases of conflict (cf. OIF, OEF and Odyssey Dawn), we can expect to see deep strike used in several other circumstances, and particularly:

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[1] Philippe Gros, *De Odyssey Dawn à Unified Protector: bilan transitoire, perspectives et premiers enseignements de l'engagement en Libye*, Fondation pour la Recherche Stratégique, Report 04/11, May 2011, pp.7-9.

[2] Barry D. Watts, *Moving Forward on Long-Range Strike*, Center for Strategic and Budgetary Assessments, September 27, 2004.

To strike targets in zones that are difficult or impossible for our forces to access: the very principle of deep strike is based on the possibility of penetrating (discreetly when necessary) airspace to neutralise targets without large-scale military deployment.

To neutralise time-critical or mobile targets on the basis of the concepts developed by the US as part of the *Conventional Prompt Global Strike* (CPGS) programme, which focuses on the ability to shorten the observation-orientation-decision-action loop even further, thereby reducing the time gap between target detection and engagement – including the necessary associated political decision and flight time – to less than one hour.[3].

To attack targets of high political or strategic value: the two impact differently on the way the force structure is defined. For targets of high political value, the crucial question focuses on the possible consequences and effects of using strikes. The existence of this problem justifies the fact that **every decision** to engage reverts systematically to the executive authorities (without delegation, which may be the case for the more general use of air power).

The neutralisation of enemy strategic capabilities, which is the scenario that dominates US thinking on the prospect of a possible conflict with a power in possession of anti-access[4] resources and strategy, creates technical and operational constraints, rather than political ones. In practice, it means destroying a variety of targets - from underground command centres to the command and control infrastructure and key military systems (early warning) - which could be the focus of many protective measures or significant resilience capability.

Clearly, the issue of the pre-emptive use of deep strike capability is one of the key political considerations in the acquisition decision, as is the very politico-operational architecture that underpins this capability. Some nation states - Israel being a case in point - have already used conventional strikes in the context of preventive action, especially against installations seen as contributing to proliferation[5].

This was the case, for example, with the destruction of a nuclear reactor of allegedly North Korean origin in Syria in September 2007 as part of *Operation Orchard*. It is interesting to note both the extent of the operation and the way in which the US and Israeli governments managed the communication aspects after the event. In his memoirs, President George W. Bush recalls that having been contacted by the Israeli Prime Minister with a request that the US should mount the operation, he did not agree on the basis that the information available did not definitively confirm the existence of a *military nuclear* role for the site[6]. The President's judgement was that military action would be acceptable only if the intelligence services confirmed the existence of a

[3] Such a lead time restricts options for action. Committee on Conventional Prompt Global Strike Capability, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, National Research Council, 2008, p.21.

[4] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p. 2. This type of scenario is found in: Todd Schull, *Conventional Prompt Global Strike: Valuable Military Option or Threat to International Stability*, Naval Postgraduate School, September 2005. It involves consideration of an Asian war scenario involving China.

[5] http://en.wikipedia.org/wiki/Operation_Orchard

[6] George W. Bush, *Decision Points*, Virgin Books, 2010, pp. 420-422.

military nuclear programme and that this site was part of that programme. Many options were considered during the preparatory phase, ranging from air-land action to a raid by Special Forces and politico-diplomatic pressure.

Although some uses border on a practical operational purpose - destroying military assets to support an airborne campaign or prior to entry into theatre - it is clear to see from this example that deep strikes may be used in much more politicised contexts that require political decision-making.

Ultimately, the deep strike function must, if it is to develop, address a series of technical and operational constraints, political and strategic issues (including the ethical and legal considerations surrounding the use of force) and financial questions.

In the final analysis, these factors must be taken into account to improve the process of identifying the operational needs relating to ***future deep strike missions***. On this basis, it would seem possible to compare the technological options (including providing the information required to resolve the issue of the best vehicle/effector combination) available for implementing this type of mission. In this regard, consideration must also be system-focused to address not only in terms of the delivery assets (missiles and, where appropriate, their carriers/platforms), but also the **enabling capabilities that play an important, even critical role**[7]: reconnaissance and intelligence capabilities, including digital data acquisition assets, communication assets and effect evaluation systems[8].

However, the choice of deep strike architecture and assets also demands consideration of the strategic aspects surrounding the use of these capabilities. So the use of nuclear delivery assets (ballistic or cruise missiles) for conventional operations inevitably raises issues over the interpretation of such firings by other powers, and especially nuclear powers, inasmuch as they are capable of detecting the fact of firing[9].

Over and above resolving this specific issue, there is also a need to clarify the key structural elements of the policy and concept surrounding the use of such a function. This must enable the resolution of those uncertainties that may potentially influence the political and operational conditions under which the deep strike system could be used[10]. There can be no doubt that it would not be sufficient simply to take account of those issues as they exist today, but rather to review them in light of how key factors are evolving. This should also include work on the constraints impacting on the command and control chain (especially time constraints/speed of decision-making, the forwarding of decisions to units, subsidiarity between command and decision-making levels, etc.). In addition to the aspects of analysis referred to above, it would seem useful to consider how the deep strike functions of some major military powers have evolved.

The US have, as part of its considerations on conventional strategic strikes (*Prompt Global Strikes*), conducted an analysis of their ultimate purpose and implementation.

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[7] Which could also be described as support assets playing a critical role in strike effectiveness.

[8] Defense Science Board, *Time Critical Conventional Strike from Strategic Standoff*, Office of the Secretary of Defense for Acquisition, Technology, and Logistics, March 2009, p. 1.

[9] Please note that this issue will be addressed only implicitly in the context of this report.

[10] National Research Council Committee on Conventional Prompt Global Strike Capability, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, 2008, p. 10.

They have also addressed the issue in the context of anti-proliferation and the war on terror by assessing the role of this type of system in neutralising proliferation capabilities and terrorist leaders. In terms of research and development, Washington may well have invested in programmes designed to create options for a future capability to strike further and/or faster (hypersonic cruise missile, conversion of Trident ballistic missiles, etc.), but it has also developed, deployed and used less futuristic solutions designed to offer great flexibility to its armed forces and intelligence services in the form of armed UAVs and cruise missiles. An evaluation of US policy and possible developments appears relevant to provide input to considerations surrounding the organisation of deep strike and the envisageable technological solutions.

Israel, which has conducted many deep strike operations to neutralise enemy capabilities, would also seem to be a relevant example for analysis. For this purpose, the Israeli leadership has consistently relied on the use of piloted aircraft conducting high-speed raids with no warning. Analysis of the data and information available about these operations - not only from the operational point of view, but also in terms of political and strategic management - may serve as a measure with which to assess the relevance of such a model for those missions that concern France.

Lastly, in common with France, **the UK is one of the few European countries with long-range strike capability** (with *Storm Shadow* for the air force and the *Tomahawk Land Attack Missile* for the navy). Against a background of budget cuts, it may be instructive to consider the changes made by London to its strategy in this area. In addition to the relevance of this issue compared with the situation in France, the choices made in Britain will also be important in terms of joint operations, such as those envisaged under the UK-France Defence and Security Cooperation Treaty of November 2010.

Long range strike operations must respond to new strategic, technical and operational needs in the period 2020-2025

Table 1 : Structural elements for long range strike operations

TYPE OF TARGET	CHARACTERISTICS OF TARGETS AND THEIR ENVIRONMENTS	FIRING TIME/DISTANCE	ENVIRONMENT AND CONTEXT OF USE	ENEMY
Civilian hardware or building	Fixed or relatively immobile targets	Close (less than one hour)	Dense urban	State with which we are not at war
Military hardware or building	Mobile or rapidly relocable targets	Medium-range (less than four hours)	Low density urban/Peri-urban	State with which we are at war
Individual or group of individuals (political or military decision-maker(s))	Hard targets	Long-range (between 4 and 24 hours)	Industrial site (potentially polluting, e.g. nuclear, chemical or biological)	Non-governmental organisation (terrorist, guerrilla, etc.) operating from a State with which we are not at war
Individual or group of individuals (soldiers or other combatants)	Soft surface targets	Very long-range (several days??)	Populated area	Non-governmental organisation with no specific geographic base
Civilian population	Protected targets (e.g. by air defence systems)		Desert area	
	Time-critical targets[11]		Maritime area	
	Concealed or camouflaged targets			

The *Defense Science Board* report on the future of strategic strike operations published in 2004 details the considerations that should structure the architecture of this function – which could be similar, given the US context of deep strike operations as we define them[12] – in the period to 2030[13]. The DSB considers that the goal of a strategic strike is to "bring about rapid change in the strategic and military options (courses of action) open to an enemy". It makes clear that these assets must be able either to reach enemy capabilities directly, or influence the enemy's decision-making processes.

[11] These may be targets that are not initially pinpointed, but which are identified during an operation and whose neutralisation is desirable.

[12] cf. introduction.

[13] Defense Science Board, *The Future of Strategic Strike Forces*, February 2004, p. 2.1.

In clarifying the scope of this survey, it seems to us essential that the deep strike function should meet two key goals:

⇒ the ability to reach a target several hundred kilometres[14] away from the deployment positions of our own forces: this necessarily excludes direct fire operations (artillery, close air support, etc.)

⇒ the ability to strike targets in protected or even defended areas: it is essential to bear in mind that deep strike operations can be conducted even though the air defence potential of the target remains intact.

> Defeating adversary aggression will require the Joint Force to support National approaches to counter anti-access and area-denial strategies. Anti-access strategies seek to prevent our Nation's ability to project and sustain combat power into a region, while area denial strategies seek to constrain our Nation's freedom of action within the region. Defeating these strategies will require Joint Force doctrine to better integrate core military competencies across all domains and account for geographic considerations and constraints. These

Figure 1: Anti-access and area denial strategies are critical risks for US forces (source: The National Military Strategy of the US – 2011)

Having raised this point, it seems that one of the most restricting factors for the time period under consideration is the proliferation of assets designed to deny armed forces freedom of manoeuvre in a theatre of operations, or even within an area or region (access denial), especially in the context of projection operations outside their areas of influence[15]. The threat of access denial, its particular enforcement in the form of enemy surface-to-air, submarine warfare and land warfare capabilities and the reality of area denial (that is to say the possibility of preventing or delaying the establishment of the logistics and combat bases required to conduct operations in theatre) must be considered as completely realistic given the availability of modern surface-to-air systems and the efforts made by many countries in anti-ship warfare and submarine detection[16]. In fact, the *National Military Strategy of the United States 2011*, a political document setting out the structure for military and strategic reviews, positions anti-access (space, maritime, airborne and cyber) strategies at the centre of those risks that threaten the freedom to manoeuvre of US forces and their ability to act against a regional enemy. In a more general sense, Washington considers that freedom of access to *global commons* (that is to say the ability to manoeuvre in, and make free use of, international spaces: air, sea, space and cyber) is a key security issue.

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[14] Although this distance is given purely for illustrative purposes, it highlights the fact that the target is assumed to be a long way from our forces on the ground. This thinking is based on the concept of power projection, which may or may not be associated with force projection. Please refer to paragraph 1.1.1. for further information on this point.

[15] For anti-access issues, see C. Brustlein, *Vers la fin de la projection de forces : la menace du déni d'accès*, IFRI, Focus Stratégique N°20, April 2010.

[16] At the current time, the exportability of the Russian S-300 and Tor-M1, and the progress being made by the Chinese in surface-to-air defence systems demonstrate that the trend is towards increasingly sophisticated surface-to-air assets.

Conventional Prompt Global Strike: An ambitious US deep strike programme.

Introduced by the Bush Administration following publication of the *Nuclear Posture Review* in 2001, the Conventional *Prompt Global Strike* programme is intended to provide the conventional offensive pillar of the new triad. The stated aim of this project was to offer the President the option of striking any target anywhere in the world in one hour or less.

Since then, following publication of the defence review of 2006[17] and development of the *Prompt Global Strike* concept in 2005[18], a number of projects have been revived by the US Navy and US Air Force. Prior to the election of President Obama, the use of existing Trident and Minuteman launchers were the favoured options of the administration, since the ballistic missile conversion programmes were less costly than developing specific solutions, despite the fact that they required the development of new warheads. But the overriding appeal of this solution was that the first capabilities could be deployed rapidly, within just a few years.

However, this solution encountered significant reluctance in both the Senate and the House, which felt that, if used, it would raise the risk of misinterpretation by the Russian government, which might see it as a use of nuclear capability.

These reservations expressed by Congress undoubtedly resulted in the new government giving up on the ballistic missile conversion solution to continue development of new hypersonic systems. Nevertheless, the Obama administration has continued to support the development of this capability.

Whichever solution is eventually deployed - and we can assume that budget cutbacks will result in the programme being postponed - no one in Washington believes that CPGS should take the form of a massive deployment of conventional strategic assets, but rather the implementation of a limited capability suited to one of strikes against particular targets of strategic value.

In the period to 2025, the long range strike function therefore seems likely to play an increasing role in the panoply of assets available to counter anti-access and area denial strategies and even, in certain scenarios, to neutralise the contributory assets[19]. Confirmed by successive defence secretaries in the last decade, the US decision to complement the range of strategic and tactical strike assets upwards (*conventional prompt global strikes*) and downwards (armed UAVs/reprogrammable long-range cruise missiles) illustrates the importance placed on the comprehensive cover of this capability, which occupies the crossroads between general deployment in times of conflict and sparing use during peacetime.

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[17] *Quadrennial Defense Review report* 2006, http://www.defenselink.mil/pubs/pdfs/QDR20060203.pdf

[18] Amy F. Woolf, *Conventional Warheads for Long-Range Ballistic Missiles: Background and Issues for Congress*, op. cit., p.5.

[19] John A. Shaud, Adam B. Lowther, *An Air Force Strategic Vision for 2020-2030*, Strategic Studies Quarterly, Spring 2011, pp.9-10.

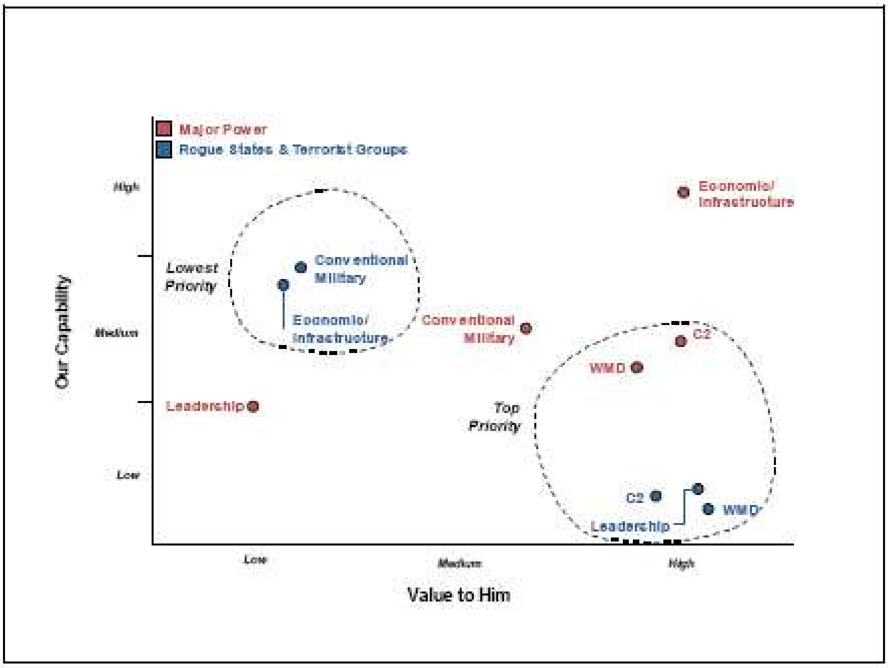


Figure 1-2: U.S. strategic strike capability: baseline.

Figure 2: Possible strategic strike targets and delivery capabilities (source: Defense Science Board – 2004)

Some of the strategic, political, technical and operational factors that will structure the deep strike function in the period to 2025

Defining the role of strategic strike capability helps us - at least in the schematic sense - to identify the key factors that must be addressed in developing the architecture of this function over the period under consideration.

By way of initial analysis, Table 1 sets out some of the elements likely to structure the function over the period under consideration. It identifies the range of factors capable of influencing the organisation and structure of the deep strike function. We will return to the key factors in more detail, but it is relevant to highlight at the outset that all the indicators point to this function being (and continuing to be) extremely constrained at every level (political, human, technical and military), **which supports the view that it should be organised and structured to encourage a high level of flexibility in terms of employment and engagement decision, at the same time as remaining under the relatively narrow control of political authorities**.

It seems helpful to clarify that the compromise between strict political control and operational flexibility could take the form of firing authority being delegated to military command structures in the context of a pre-planned action, subject to clearly defined rules of engagement and periodic reviews by the Chiefs of Staff and executive authorities. For example, it would appear feasible to list possible time-critical targets, which, if detected by friendly intelligence assets, could be targeted by deep strike weapon systems on the basis of rules of engagement defined in advance[20]. Such a situation would - naturally - require that the lists and rules of engagement were systematically reviewed by the executive in order to ensure their evolution on the basis of general circumstances and the contexts specific to particular crises and conflicts.

It is interesting to note that as things stand, there are two main approaches governing the use of deep strike. The first is founded on the principle that this type of strike involves strategic operations and that the authority for decision-making inevitably reverts directly to the executive with no possibility of delegation. The result of this approach is to introduce substantial delay into the time lag between the scheduling and preparation of a series of strikes and their possible implementation using the assets in place. Conversely, several countries – the US in particular and, to a lesser degree, the UK - believe that the level of delegation governing the use of deep strike systems should relate primarily to the nature of the target concerned: an attack on enemy military assets and/or forces would not require a decision by the Head of State, although such a decision would be required if the strike target were of high political or strategic value.

Analysis of targets for potential attack by the deep strike function:

The diversity of targets that deep strike is likely to be called upon to neutralise would seem to be a key element in defining the assets and organisational structures required to fulfil this function.

This diversity, which should continue to grow between now and 2025, relates to multiple target characteristics:

⇒ **Attitude:** mobility, time sensitivity, camouflage or concealment measures and the distance between the target and the delivery platform. For example, deep strikes should be able to attack moving targets - even if a compromise must undoubtedly be found on this point between the neutralisation of moving vehicles[21] and the engagement of a target which may move sporadically (*relocable*) – as well as fixed targets, such as physical infrastructures.

- The time sensitivity[22] of some targets is likely to continue to raise particular difficulties inasmuch as (1) the political authorities will want deep strike assets to offer an additional option over and above those of other weapons systems in order to resolve occasional or one-off situations[23] and (2) we are

[20] Tara McKelvey, *Inside the Killing Machine*, Newsweek, 13 February 2011. We address this issue in greater detail later in the report.

[21] This option raises significant technical issues when we assume that the weapon system used is a guided weapon (thus excluding the use of special forces) due to the time elapsed between launch, in-area arrival and target engagement. In reality, the situation is rather that the presence of a platform close to the target inevitably offers the best results, which seems to depart somewhat from the working hypothesis of deep strike. See Defense Science Board Task Force, *Time Critical Conventional Strike from Strategic Standoff*, March 2009, pp.69-72.

[22] The terms *time-sensitive* and *time-critical* refer to the fact that the window of time during which the target may be effectively attacked by strike assets from the third dimension is limited. Ibid, p.1.

[23] The textbook example here would be to kill enemy leaders known to be present for a limited period in unknown location. The attempt to neutralise Saddam Hussein at the start of the Iraq conflict is a good example. On the basis of intelligence gathered, the President authorised strikes by an F-117 bomber on part of the Dora Farms, where the Iraqi dictator and his family were known to be, but the attempt failed despite less than one hour expiring between detection and the arrival of the effector. The example of missile launchers also

likely to see a continued increase in the number of instances in which deep strike would offer a plausible option, due to the technical upgrades applied not only to effectors, but also to enabling capabilities (the communication and command circuit, sensors and intelligence systems, etc.)[24]. The scenarios envisaged by the DSB in the 2009 report on time-critical target strikes once again highlighted the need to address a variety of circumstances, including, for example, the transport of proliferation-related equipment, meetings of terrorist leaders, non-conventional anti-access assets and the destruction of critical industrial capacity[25].

- It is also important to consider those measures which could be taken by enemies to camouflage or conceal the target (within its environment) in order to reduce the risk of its neutralisation by strikes or other military action. On the one hand, concealed or camouflaged targets add complexity to the initial stages of planning: the absence of prior intelligence regarding their environment and coordinates requires the planner to have access to listings of targets covering all the territories in which a target could be present. On the other hand, by delaying the moment of detection, the enemy automatically reduces the time available to engage the target (cf. fig. I). In terms of chronology, it is important to take account of the fact that the engagement window must include any additional strikes on the target decided upon following analysis of the initial battle damage assessment[26].
- The distance between the target and the platform (or at least between the target and the final position in which the platform can be supported[27]) is ultimately one element of the target attitude that will have a key influence on the choice of assets/weapons systems that can be employed to attack it. As remarked upon elsewhere by certain American commentators[28], the targets to be neutralised may be placed intentionally by enemies in very remote areas – sometimes highly protected against anti-access strategies (cf. below) – several thousands of kilometres from coasts or borders. In such scenarios - which may become more common as asymmetric combat strategies are introduced - the inherent range of the weapon system becomes a key element in its mission delivery capability[29].

illustrates the possibility that the target is present in a given location only for a limited period of time. Barry D. Watts, *Moving Forward on Long Range Strike*, Center for Strategic and Budgetary Assessments, September 27, 2004, p.14.

[24] We will return to these issues in the next section.

[25] Defense Science Board Task Force, *Time Critical Conventional Strike from Strategic Standoff*, March 2009, p.2

[26] Barry D. Watts, *The Case for Long Range Strike: 21st Century Scenarios*, Center for Strategic and Budgetary Assessments, 2008.

[27] Barry D. Watts, *Testimony before the US Senate Armed Services Committee – Airland Sub Committee: Long-Range Strike*, 30 April 2009, p.3. Watts confirms that the known maximum operating range of a B-2 is approximately 2,000-2,500 nautical miles, and that therefore the distance to the target is ultimately a discriminating factor in strike capability (or at least US strike capability).

[28] Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, pp.13-14.

[29] This reasoning is the main reason for the level of ideological support enjoyed in the USA by the option to convert ballistic missiles for conventional strike missions.

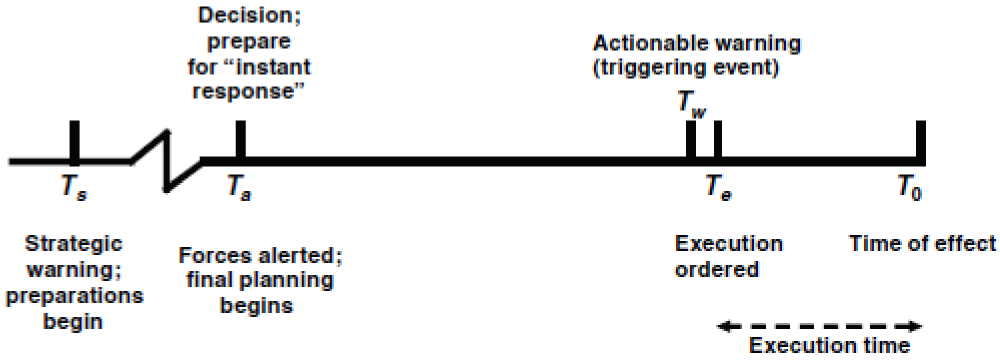


Figure 3: Chronological sequence of the strategic/deep strike preparation and planning process – this figure assumes that the engagement cycle begins with detection of the target (triggering event) (source: National Research Council 2008)

⇒ **The environment** includes particularly the presence of passive/active defences (likely to affect effectors and platforms, but also to compromise the effectiveness of observation and intelligence gathering systems), the existence of hardening or interment measures, and proximity to non-combatants or civilian structures of particular social, religious or cultural value.

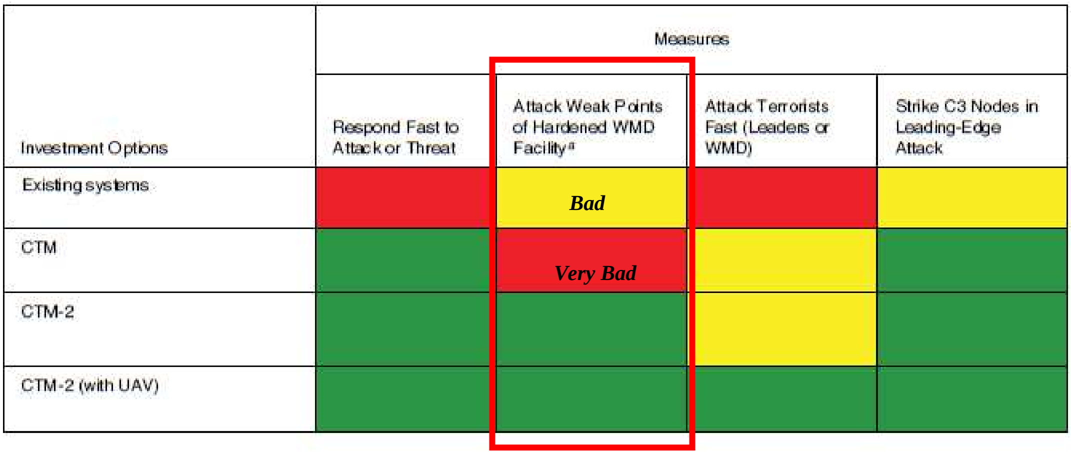
The environment around the target has proved to be a dimensioning factor for the weapon system in terms of anticipated performance, which must be capable of being accurate enough to reach the target without destroying its entire environment, and stealthy enough to penetrate enemy airspace without being destroyed by defensive systems. More specifically, the weapon system must be equipped with a warhead capable of penetrating hardened or deeply interred buildings, which present a particular level of technical challenge. It is important to highlight the fact that, at present, the assets available are not capable of attacking this type target successfully[30].

To achieve this objective, it is necessary to obtain accuracy to within a few metres at the same time as delivering very significant capabilities in terms of warhead penetration and charge destructive power. Disregarding the solution offered by a special nuclear charge, the development of one of the two feasible solutions - kinetic weapons or kinetic/explosive charges used in tandem - (or both) poses another significant technical (and therefore financial) challenge.

[30] Committee on Conventional Prompt Global Strike Capability, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, National Research Council, 2008, pp.52-53.

Figure 4: Effectiveness of alternative technical solutions by target category (source: NRC 2008)

TABLE 2-4 Evaluation of the Conventional Prompt Global Strike (CPGS) Options in a Set of Test Cases



Investment Options	Measures			
	Respond Fast to Attack or Threat	Attack Weak Points of Hardened WMD Facility[a]	Attack Terrorists Fast (Leaders or WMD)	Strike C3 Nodes in Leading-Edge Attack
Existing systems		*Bad*		
CTM		*Very Bad*		
CTM-2				
CTM-2 (with UAV)				

⇒ Reducing the collateral damage caused by the payload is another increasingly important requirement, which seems set to develop further in the years ahead. In reality, it must be acknowledged, as indeed it is by the majority of experts, that the Western powers, and particularly the USA, use military intervention to remove adverse regimes or neutralise non-national hostile organisations – sometimes on the basis of civilian safety and security – rather than to defeat enemy nations[31].

- In this respect, it is essential during the military phase of an operation to spare both the civilian population and the economic infrastructures of the country concerned so that they can be used later for the reconstruction and/or stabilisation of the nation states concerned[32]. This has to be achieved despite the fact that the enemy will have intermingled their forces with the civilian population to protect their capabilities and assets by locating them in or near densely populated areas or those with high symbolic value.

- In this regard, the possibility of using precision strikes against targets related to proliferation programmes (whether nuclear, biological or chemical) - scenarios often cited in US defence studies[33] - deserves to be discounted from a number of viewpoints. In the first instance, it illustrates the complexity of future deep strike missions, which must not only neutralise a diverse (and complex) spectrum of targets, but must also achieve that objective at the same time as minimising the secondary effects on the environment, since pollution

[31] Andrew F. Krepinevich, *Operation Iraqi Freedom: A First-Blush Assessment*, Center for Strategic and Budgetary Assessments, 2003, p. 7.

[32] Ibid, p. 13.

[33] Defense Science Board, "*The Future of Strategic Strike Forces*", *February 2004*. Neutralising non-conventional capabilities such as these is one of the priorities set out in the National Military Strategy, in conjunction with initiatives designed to prevent the proliferation of these types of weapon. Chairman of the Joint Chiefs of Staff, *The National Military Strategy of the United States of America*, February 2011, p. 3.

risks can be difficult to measure. Ultimately, this example (combined with the preceding considerations) demonstrates that deep strikes must respond simultaneously to the need for very occasional use to counter limited threats (the niche concept) and the need to be employed on a more sustained basis in tactical operations, for example (typically suppression of enemy air defences - SEAD - missions). But it is also important to highlight the need to neutralise weapons proliferation capabilities - one of the ideological markers of the Bush administration in terms of security and the main reason put forward to justify American thinking on preventive strikes - which remains an ongoing issue within the current US administration, confirming the sustained nature of the US preoccupation with this type of risk. So, like the work previously done in 2004 and 2008[34], two of the five *Defense Science Board* prompt strategic strike dimensioning scenarios of 2009 are based on the neutralisation of non-conventional threats. The role that could be assumed by deep strike weapons in the context of counter-proliferation, counter-terrorism or counter-insurrection missions is based on the fact that the targets concerned are often difficult to access, and demand high levels of performance in terms of preparation, intelligence and operational command (thereby imposing significant constraints on the associated operational cycles).

- Lastly, existing active defence capabilities will contribute to making the immediate target environment and access roads increasingly difficult to address. The modernisation of air defence assets is only one part of the increasing complexity surrounding access; others being developments in anti-submarine, anti-satellite and anti-ship measures, which have a direct impact on deployment opportunities and platform operations[35].

⇒ Lastly, **the type of target** (weapons systems, infrastructures, personnel, etc.) is already a critical element to be addressed when effectively defining the assets to be used in a precision strike, including in the preparation and planning phases. The diversity of targets that could potentially be attacked and the operational constraints that characterise such operations go a long way to justifying the need for flexibility throughout the deep/strategic strike utilisation cycle (from initial planning to neutralisation attempts and repeat strikes). The same need for flexibility also applies to launch platforms and – potentially – effectors.

- More specifically, this diversity highlights the intrinsic duality of the function, which is not only highly strategic, but also has a fundamental operational dimension: that of operational continuity of strike missions from the third dimension. For example, the fact that conventional prompt global strike (CPGS) – for which the underlying principle was first put forward by the *Nuclear Posture Review* of 2001 - forms part of a wider grouping of strategic options that includes anti-missile defence and the nuclear deterrent, and together with these two assets extends the options available to the

[34] By the National Research Council, Committee on Conventional Prompt Global Strike Capability, *US Conventional Prompt Global Strike: Issues for 2008 and Beyond*, 2008.

[35] US Department of Defense, *The Quadrennial Defense Review*, 26 January 2010, pp.31-32.

executive authority for addressing an increasingly diverse range of situations[36].

- Technical progress and the increasing need to take action beyond those areas under military control or with suitable infrastructures (including logistics platforms), against organisations - whether nation states or otherwise - in all circumstances (e.g. in peacetime) and to do so with short alert lead times are all considerations likely to further increase the diversity of potential deep strike targets[37].

⇒ ***This expansion of the spectrum of targets*** is likely to lead to more consideration being given to the efficiency of the strategic strike function, particularly given the trend towards greater budgetary constraint and the resulting impact on new weapons system acquisitions, and even the conduct of operations. Because of the need to use warheads that meet specific performance criteria (the penetration/thermal effect combination, for example), the issue of attacking complex targets should be examined in light of the need to reduce weapons costs; some of those reductions will be made possible by technological progress in all propelled/guided weapons sub-systems.

In recent conflicts, the use of precision weapons has become systematic, even if the launch of standoff strike assets (cruise missiles) remains overall less frequent than that of guided bombs: since 1991, US forces have fired more than 53,000 guided weapons, of which 78% were bombs (JDAM/laser-guided bombs) and only 3.1% Tomahawk missiles (Tomahawk Land Attack Missile and Conventional Air Launched Cruise Missile)[38]. The increase seen in the total proportion of guided weapons used during conflicts since the first Gulf War - from a few percent to nearly two-thirds of all firings - shows how vital they have become in the conduct of operations.

Nevertheless, it should be noted that the total guided missile launch capability of U.S. Navy ships - including all available vertical launch assets - is likely to be in excess of 10,000[39]. The limited use made of deep strike assets reflects primarily on the high cost of the weapons used: even for fairly large production volumes, a Tomahawk block-IVA cost around million dollars[40], compared with the price tag

[36] Neither, for that matter, is this reasoning valid only from a French perspective. Some American experts remain convinced of the conceptual continuity between deep (or standoff) strikes and strategic strikes (whether prompt or otherwise). Elaine Bunn and Vincent A. Manzo, *Conventional Prompt Global Strike: Strategic Asset or Unusable Liability*, National Defense University, Strategic Forum, February 2011.

[37] Cf. below for a development update on the likely evolution of the international context and the constraints impacting on this function in the period to 2025.

[38] Barry D. Watts, *Moving Forward on Long-Range Strike*, Center for Strategic and Budgetary Assessments, September 27, 2004, p. 5.

[39] This figure is purely illustrative, and takes account of the fact that the Mk-41 launch systems carried by US battlecruisers and destroyers are designed to carry other types of weapons system: air defence, anti-ship, etc.

[40] http://www.navy.mil/navydata/fact_display.asp?cid=2200&tid=1300&ct=2 This website indicates a unit price of $569,000, but given the existing data, it would be reasonable to estimate that the cost of acquisition (which includes production and development costs) is actually around $1 million. See also: Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects*, CSBA, March 2007, p. 230 and p. 237.

of a JDAM kit for a Guided Bomb Unit (GBU) of a few tens of thousands of dollars.

Table 2 : Use of cruise missiles by the USA since 1991 (source: Center for Strategic and Budgetary Assessments 2007)[41]

Period	Name of operation	Tomahawk Land Attack Missile	Conventional Air Launch Cruise Missile	Total
Jan-Feb 1991	*Desert Storm*	298	35	333
January 1993	*Southern Watch*[42]	45	0	45
July 1993	*Southern Watch*	23	0	23
September 1995	*Deliberate Force*	13	0	13
September 1996	*Desert Strike*	31	13	44
August 1998	*Soudan & Afghanistan*[43]	79	0	79
December 1998	*Desert Fox*	325	90	415
March-June 1999	*Allied Force*	198	72	270
Oct-Nov 2001	*Enduring Freedom*	74	0	74
March 2003	*Iraqi Freedom*	802	153	955
March 2011	*Unified Protector*	199	0	199
Total		2,087	363	***2,450***

The cost comparison would be incomplete unless accounts were also to be taken of the budgets required for platform deployment and mission conduct. In this respect, the solutions piloted are probably more costly in terms both of operational deployment - whether projecting an aircraft carrier battle group or combat aircraft - and the use of cruise missiles launched from surface vessels or submarines. As an illustration, the operation in Libya - that is to say in an area relatively close to home - will have cost around €1.8 million on average for thirty per day.[44] In addition, it is also important to consider the specific constraints on the use of land-based solutions in terms of overfly rights or 'basing', which may reduce the relevance of their use, or even rule it out altogether in certain circumstances.

Although the trend towards systematic use of autonomous long-range weapons (typically cruise missiles) for deep strike missions seems to be the case - on the other side of the Atlantic, at least - the increasing diversity of targets should automatically result in an increase in stockpiles of this type of weapon, particularly in the case of non-expeditionary powers, i.e. almost all western states, with the exception of the USA. Such an increase is particularly justified where the conditions of deployment outside the homeland do not permit the local basing of combat aircraft, and where few companies have fleets of bombers capable of operating at very long range.

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[41] Barry D. Watts, *Six Decades of Guided Munitions and Battle Networks: Progress and Prospects*, Center for Strategic and Budgetary Assessments, March 2007, p.238.

[42] Etablissement et maintien d'une zone de non survol au sud de l'Irak.

[43] Traitement de camps d'entraînement d'Al Qaïda après les attentats contre les ambassades américaines en Afrique.

[44] http://www.marianne2.fr/blogsecretdefense/La-guerre-en-Libye-coutera-entre-300-et-350-millions-d-euros_a356.html

Lastly, it is important to emphasise that the increasing need to possess the capability of striking large numbers of diverse targets that are complex to characterise technically (e.g. in terms of their environment) and difficult to access could lead to competition between recourse to operations conducted by highly trained small groups capable of operating in enemy territory (special forces) and the use of flexible, prompt, long-range weapons systems.

A number of political and strategic issues will influence the development and use of the deep strike function

We have seen that the diversity of potential deep strike targets means that deep strikes will probably continue to play an eminently strategic role in the panoply of conventional capabilities available to nation states. However, the political and strategic dimensions of this system are more far reaching, since some targets are more political in nature, which, in itself merits special consideration from the policy point of view.

Defense and Mitigation

Because deterrence may not succeed, and because of the potentially devastating consequences of WMD use against our forces and civilian population, U.S. military forces and appropriate civilian agencies must have the capability to defend against WMD-armed adversaries, including in appropriate cases through preemptive measures. This requires capabilities to detect and destroy an adversary's WMD assets before these weapons are used. In addition, robust active

Figure 5: Paragraph on pre-emptive measures taken from the National Defense Strategy to Combat Proliferation (source: National Security Presidential Directive 17 - White House 2002[45])

So in light of current debates and those that have taken place over the past decade, a number of issues merit further examination in order to identify the operational framework of deep strike capability and the conditions under which these strikes may be used:

- ⇨ The possibility of using available assets **preventively or even pre-emptively** to neutralise an asset or person was discussed *ad nauseam* over the 10 years that began in 2000, when the idea was first voiced by the Bush administration. It may be useful to consider the following elements, which emerged from these considerations:

[45] http://www.fas.org/irp/offdocs/nspd/index.html

- The principle of using force against a country or organisation **which is about** to gain a non-conventional capability of strategic significance (a nuclear weapon) or instigating major terrorist or military action against the vital interests of the nation concerned seems not to have been excluded *ex abrupto*. Even though the systematic use of strikes to neutralise or inhibit proliferating projects seems to have been ruled out - probably because they could not guarantee a sufficient level of effectiveness in certain scenarios - it is reasonable to imagine that they would be used given the existence of certain technical conditions (knowledge of targets, data enabling precise evaluation of the effects, etc.) and operational conditions (use of appropriate assets).
- **The (relatively) strict framing** applied to the conditions of use seems to be the *sine qua non* consideration in making this type of action acceptable internationally and in terms of public opinion. Precise examination of the legal aspects, without going so far as to rule definitively on the legality of pre-emptive strike, would probably show that the use of force could be justified if the risk is established (i.e. immediate) and if the measures taken to eliminate the source comply with the legal rules of engagement (proportionality).

⇨ **The burden of proof** (and the issue of post-operation media management) lies essentially on the country conducting strikes, despite the fact that the approach taken by Israel in this respect remains to limit post-action communication - or even to supply only the most sketchy information immediately after the operation[46] - at the same time as asserting that the use of force is legitimate[47]. The available intelligence - which must be able to be published - on the nature of the threat must however be sufficiently substantial and/or credible to permit disclosure of sufficient convincing evidence to establish the reality of the risk in the event of public or diplomatic debate, and in any event in the context of the long-term management of the action concerned. The data used in preparing for the action, which must meet a series of criteria[48] in order to be useful from the operational point of view, could also be used in the context of post-operation media and international management.

[46] Yves Boyer, *L'énigme de l'attaque israélienne du 6 septembre 2007*, Notes de la FRS, 24 September 2007, pp. 1-2.

[47] East-Asia-intel.com, *Israeli PM confirmed air strike targeted North Korea-related nuclear site, daily reports*, April 3, 2008.

[48] To differing degrees depending on the target: precision, reliability, comprehensiveness. This intelligence must also be accessible and available for distribution within the timeframe compatible with the planning process. Austin Long, Dinshaw Mistry, Bruce M. Sugden, *Going Nowhere Fast: Assessing Concerns about Long-Range Conventional Ballistic Missiles*, International Security, Spring 2010.

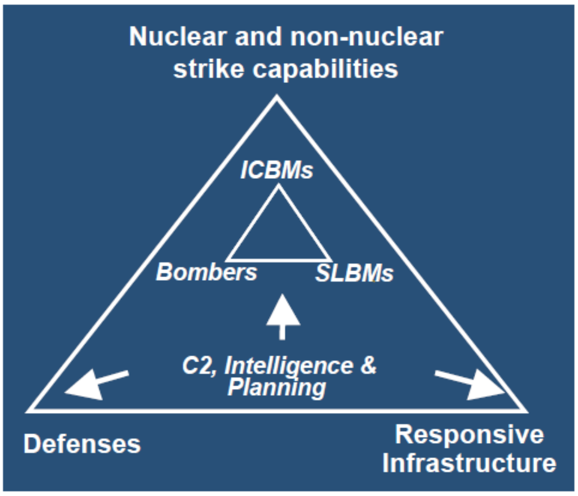

Figure 6: Schematic diagram illustrating the principle of the former "New Triad" (source: Nuclear Posture Review 2001)

- ⇨ **The conceptual scope of application for deep strike** merits clarification in order to avoid any ambiguity about the role, use and purpose of this function. The US debate (and efforts) regarding conventional prompt global strikes (CPGS) could suggest some continuity between strictly military operations and those whose purpose is strategic or forms part of a wider dissuasive policy.
  - In the first instance, the conceptual heritage of strategic strike lies in the strategic thinking that surrounds nuclear dissuasion and anti-missile defence. In putting forward the concept of the new triad, which combines nuclear and non-nuclear capabilities (cf. figure), the Bush administration made conventional strategic strike a resource that could be used on an occasional basis under the exclusive control of political authorities and would offer the president options other than a nuclear response to neutralise important targets. This concept of strictly political control and parsimonious use is further reinforced by the technical choices initially made regarding potential delivery systems: the conversion of submarine- and/or surface-launched ballistic missiles to carry conventional warheads. By positioning operational management of the prompt global strike capability at STRATCOM level, the administration did nothing more or less than strengthen the conceptual link between PGS and the nuclear deterrent.
  - But by their very nature - CPGS missions are the same as some of those covered by strategic strikes - and because the solutions adopted in response to the need for strategic strike focused on air-breathing rockets similar to cruise missiles[49], there is a real conceptual continuity between CPGS and standoff strikes. On the other hand, the latter can be employed in a wider operational spectrum including, most notably, suppression of enemy air defences (SEAD) or close air support (CAS). However, we cannot ignore the fact that

[49] The solution based on converting ballistic missiles for CPGS was discarded in 2011 in favour of developing a hypersonic vehicle (the booster-glider) with the capability to carry a manoeuvrable warhead. Tom Z. Collina, *US Alters Non-Nuclear Prompt-Strikes Plan*, Arms Control Today, April 2011.

ultimately the USA sees CPGS as fitting into the spectrum of strike assets by complementing it for use in very specific scenarios. It must be said that, even if the USA ceased development of conventional prompt global strikes, its ability to conduct precision strikes from the third dimension or via the use of Special Forces would be affected only marginally. In the worst case, and in certain very specific scenarios - where the area concerned is remote or distant from naval and/or airbases or overfly rights are difficult to obtain[50] - the USA would be unable to reach the selected targets within a response time less than the few hours within which a time-critical target should be attacked.

- Over the period of time under consideration, the issue of articulation between the combination of strategic strikes and anti-missile defences on the one hand, and the nuclear deterrent on the other, should be the subject of considerations leading to a coherent body of policy that extends beyond solely the US context. Moreover, concerns may - in common with some of the US's allies in Europe and Asia - focus on the shift in the American approach to the issue of articulation between conventional and non-conventional dissuasion[51]. In fact, this could paradoxically result in limiting the role of conventional long-range strikes exclusively to a form of pressure exerted on international actors for as long as it proves useful - and in relatively large numbers - for operational suppression missions prior to the use of precision weapons (guided bombs, short-range rockets, etc.) delivered by piloted aircraft or UAVs.

More generally, the possibility of convergence at the top end of the spectrum between nuclear delivery systems and deep strike systems, and at the bottom end of the spectrum between these systems and anti-ship capabilities, could be usefully explored for budgetary reasons in the form of technologies shared across some or even all sub-systems. Attractive as it may be, this idea nevertheless raises significant strategic issues, at least for the strategic strike segment. Over and above the risks inherent in any ambiguity over the nature of warhead carried by a delivery system – this may be partly resolved by special measures and, ultimately, by the limited nature of any conventional use[52] – a question arises regarding the risk of compromising the key technologies of nuclear strike assets in the event that a conventional delivery system falls into the hands of ill-intentioned individuals or nation states. It is therefore important to maintain a nuclear delivery system capability in which certain components maintain a degree of performance, or at least specificity, superior to that of conventional assets. In reality, this obligation excludes the development of a single dual-purpose delivery system, but could nevertheless enable the sharing of certain items of non-critical equipment.

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[50] The issue of overfly rights is a structural consideration in the operational thinking surrounding the role of PGS. See: Arms Control Association, *Interview with STRATCOM Commander General James E. Cartwright*, 2010. http://www.armscontrol.org/print/2840

[51] See: the work done by Elaine Bunn (for example). Elaine Bunn and Vincent A. Manzo, *Conventional Prompt Global Strike : Asset or Unusable Liability*, National Defense University, Strategic Forum, February 2011

[52] The issue of ambiguity over the use of delivery systems to fulfil both nuclear and conventional missions has long been under consideration by various US think tanks in the context of the ongoing programme to convert Trident for CPGS missions. Practical solutions have been considered to remove any risk of misinterpretation by Russia of such a firing, even in the case of deployment from an SSBN platform (e.g. by using specific launch areas or by firing on specific trajectories).

In the purely conventional segment, a convergence of technology between strategic long range strike and anti-ship systems is all the more worthy of consideration, since the need for both includes a certain degree of flexibility in use: in land attack missions, for example. However, such convergence would not be without difficulties in terms of proliferation. In practical terms, if we assume that we are seeking to provide future anti-ship systems with the ability to mount strikes against land targets with high levels of performance in terms of range, penetration and payload - which in reality translates into cruise/anti-ship missile convergence - the risk is the possible dissemination to potentially hostile nation states of systems that could be used to carry non-conventional warheads. For this reason, such convergence could result in reducing the export potential of dual-capability systems, and therefore their cost of acquisition for allied forces.

When all is said and done, the need for deep strike capability seems set to grow between now and 2025 to include new missions that will be relatively constraining both in operational and technical terms. Expanding the scope of usage could draw together those assets dedicated to deterrence and give them a strategic and political advantage by complementing the advantage they already have in operational terms. To achieve this, it will be crucial to engage in political debate and consultation, both at national level and with our key allies, in order to achieve effective and consistent integration of these new missions into the existing strike system.

Considerations regarding the environmental aspects of a future deep strike system

The issues previously discussed demonstrate the extent to which the platform/weapon combinations chosen to fulfil deep strike missions depend for their effectiveness on a series of assets and operational/political processes intended simultaneously to (1) prepare and conduct the missions concerned and (2) to provide a framework for the use of strikes in general, and in particular those instigated against targets of high political or strategic value.

These assets and processes fall into three essential categories:

The intelligence, surveillance and reconnaissance chain includes all the sensors (technical and human) that supply a continual stream of data about potential targets, their environments (including geopolitical and/or social contextual data[53]) and/or their approaches. It also includes the IT and human resources required to process these data and make the results available to the various users (political, military and other technical services).

Some of the processes required for deep strike operation fall into this category:

⇒ *Planning*: The essential role of this function is not necessarily to offer a permanent list of locations and people as potential targets, but to provide information that is interoperable with the other systems making up the national architecture, and can then be used to facilitate/exonerate mission preparation

[53] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p. 49.

(digital maps, enemy air defence locations, weather data, etc.). It also involves keeping an accurate and up-to-date account of the capabilities available for conducting deep strikes, including those intelligence assets available for use in the preparation phase. The planning function also includes the (military and politico-military) exercises that help to reduce response times in those scenarios where deep strike capability is used.

⇒ *Preparation/management*: This phase includes the gathering, formatting and distribution of data relating to a specific target identified by intelligence assets. It must enable the planning database to prepare the platform/weapon combinations and launch the mission. It also includes the intelligence aspects of all the engagement management/supervision tasks involved, and particularly the preparation of a battle space scenario and evaluation of strike outcomes.

The command and control loop incorporates all those procedures relating to effector use authorisation and decision-making processes, as well as the communication assets used to monitor and manage the engagement. It also specifically includes the secure communication assets that enable transmission of commands, target-related technical data and decision support data (including real-time outcome evaluation intelligence)[54].

The warhead cannot be dissociated from the delivery system that carries it. Nevertheless, inasmuch as the strike system must be able to neutralise a variety of relatively important targets under a variety of different conditions, it must be considered as a system in its own right. In this context, it is more about the range of warheads available and the balance/articulation between the conventional and nuclear arsenals, rather than about the individual performances of one technical solution or another.

[54] These communication assets may share certain characteristics with those used to support strategic assets (reliability, integrity, redundancy, etc.).

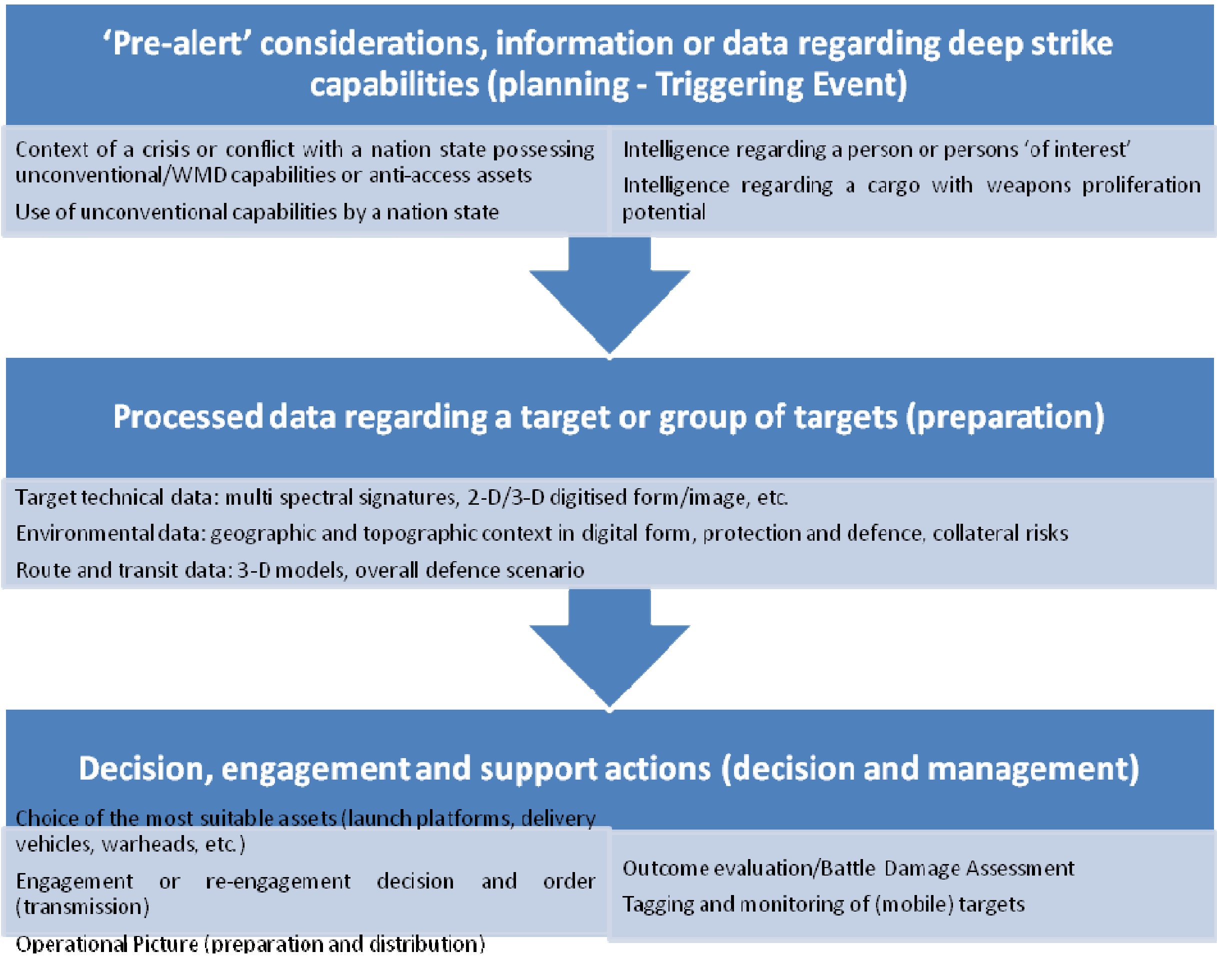


Figure 7: Strategic strike engagement and operations management cycle

The increasing complexity surrounding the conditions under which deep strike may be used, combined with the diversification of targets that may potentially be attacked using this capability, has multiple consequences for these processes and the assets associated with them:

⇒ The pressure placed on the intelligence loop is significant, and is likely to remain high level throughout the period under consideration: the need to reduce engagement lead times, the ability to strike perfectly characterised targets with extreme precision, the need to receive alert data in almost real-time (when a target exposes itself to attack) and detailed information about strike outcomes. All of these issues combine to place even more emphasis on access to, and treatment of, intelligence data: data gathering assets must be complementary not only in terms of their spectrum of data (visual, audio, other signals, coordinates, etc.) and data sources, but also in terms of the ongoing presence (satellites, UAVs, human sources, etc.) and technical accuracy of the data gathered[55]. It is important to stress that the process of acquiring usable - i.e. reliable and useful - data for the purpose of conducting deep strike operations (actionable

[55] Austin Long, Dinshaw Mistry, Bruce M. Sugden, *Going Nowhere Fast: Assessing Concerns about Long-Range Conventional Ballistic Missiles*, International Security, Spring 2010.

intelligence) is likely to remain a lengthy one. Neither is there any guarantee that it is certain to produce usable results - i.e. results offering the degree of accuracy and comprehensiveness required to engage in strikes under conditions compatible with the conflict or crisis - especially with regard to targets of high political value, which are inevitably protected by many camouflage, protection and security measures[56].

Intelligence also makes a full contribution to the more overall management of a military engagement based on deep precision strikes and actions. This means[57]:

- Obtaining intelligence prior to engagements - this may include preliminary mapping of potential targets - as the basis for specifying the conditions for the use of airborne assets and setting the rules of engagement.

- Controlling the risks faced by the units engaged, despite the fact that the time window between a political decision to take action and the engagement of forces may be extremely short (36 hours in the case of Libya).

- Possessing accurate data on enemy operational assets and locations: the need to guarantee access to strategic and operational intelligence (understanding the enemy and interpreting his movements) and the availability of the real-time data required to identify targets within their environments and make prompt choices about their attack.

⇒ Over and above the specific performances expected of sensors and the necessary level of complementarity between the platforms employed for their use, the effectiveness of the intelligence system will therefore depend heavily on the intelligence orientation and processing loop. In this latter respect, the possibility of progressing to a relatively collegial management of intelligence sources[58] deserves exploration with the aim of obtaining the vital data required for preparing or conducting strikes within lead times compatible with certain scenarios of use.

- Shortening the time taken to process data will probably be addressed first by the emergence of IT tools capable of conducting certain filtering tasks or even processing emerging data unaided. But this alone would not appear to be sufficient for processing a potentially high number of very different targets at the same time on the basis of increased demands in terms of impact accuracy and intelligence on the outcomes of each strike[59]. Functional enhancements must also undoubtedly be applied at every link in the information processing chain such that multiple departments are capable of processing data in parallel and data merging is be as fully automated as possible. The example of the lead time required to engage a high-value target in Iraq - Saddam

[56] This is undoubtedly less true for relatively well-characterised military targets, such as vehicles or surface-to-air batteries.

[57] Général d'Armée Aérienne Palomeros, '*Quelles leçons pour les forces armées après les opérations en Libye ?*', Club Athéna, 12 October 2011.

[58] Orientation des sources puis analyse des données obtenues.

[59] Barry D. Watts, *Moving Forward on Long-Range Strike*, Center for Strategic and Budgetary Assessments, September 27, 2004, pp.13-15.

Hussein, his two sons and a number of Ba'ath party leaders in this instance – in 2003 was reduced to half an hour, but was still not short enough to achieve the desired outcomes[60].

⇨ **The way in which the command system is defined must result in a satisfactory compromise between political control of strikes on targets of high value, and a greater level of delegation for those of a more operational type.** Given changing functional needs, and particularly those related to the targeting and engagement of time-critical targets, this compromise could be difficult to achieve. This task is made all the more complex since it must take account of the conceptual considerations surrounding the articulation between strategic and operational capabilities. The physical separation of engagement chains of command may also be envisaged as an initial solution capable of ensuring a visible segregation, although since it involves the use of the same systems, it represents an additional cost which could be difficult to justify in the foreseeable context of budget reductions. It must also be borne in mind that increasing the number of responsibilities per operator could impede the effectiveness of strikes, particularly inasmuch as it could extend lead times and, under certain circumstances, result in incorrect choices or decisions[61].

In any event, the command and control system must meet the following requirements as a minimum[62]:

⇒ ***In all cases, the final decision to use strikes*** must be taken by one person with national political authority or a named individual delegated as his or her representative. It is possible to envisage a fairly broad spread of delegation subject to conditions agreed in advance for the general use of strikes, and a more traditional decision-making cycle for targets of high political or strategic value.

⇒ ***Communication between actors separated geographically must be secure, prompt and reliable***. This is particularly true for communications between the operational level responsible for carrying out the strikes and the command centre tasked with managing all engagements conducted simultaneously in the theatre or region. The option of delocalising part of the command loop (i.e. locating control assets as close as possible to the theatre of operations) may be considered as a route to accelerating the pace of decision-making.

⇒ ***Target and operations execution data*** - including those conventional actions decided upon and executed in-theatre - must be ***distributed and shared between all the parties involved in the use of strike capabilities***[63] and be accessible in its totality and at all times to the decision-making authority.

⇒ ***An IT system capable of integrating the information and data fed back from theatre*** - including technical intelligence on outcome evaluation/BDA - to

[60] Ibid.

[61] Committee on Conventional Prompt Global Strike Capability, *U.S. Conventional Prompt Global Strike: Issues for 2008 and Beyond*, National Research Council, 2008, p. 57.

[62] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p. 61.

[63] And probably between those responsible for planning and the parties involved in-theatre, in-region and in-area. Jonathan M. Owens, *Precision Global Strike: Is there a Role for the Navy Conventional Trident Modification or the Airforce Conventional Strike Missile*, Air War College, 15 February 2008, p. 22.

provide a summary overview usable by decision-making authorities and the level of command responsible for action preparation/monitoring would seem to be essential[64]. In order to reduce the lead time for using direct strikes to ensure the ability to react promptly when time-critical targets appear, it is particularly important to be in possession of systems that provide maximum automation of as many phases as possible and to feed actionable data into the control loop in as near real-time as can be achieved. In this respect, significant progress has already been achieved since the early 1990s, at which time several days were needed to prepare a strike, compared with the OODA loops of today's Afghanistan, where fire support can be provided within just a few minutes[65]. It should be borne in mind that command and control system architecture must ultimately address a series of constraints, from the need to guarantee ***procedural operation*** (validation of firing authorisations, the reliability and integrity of communications between authorities and mission leaders, fast-track loop between sensors and effectors, etc.) to ***mission control and management*** (preparation and presentation of the overall situation in-theatre, integration of intelligence data, real-time planning of follow-up actions).

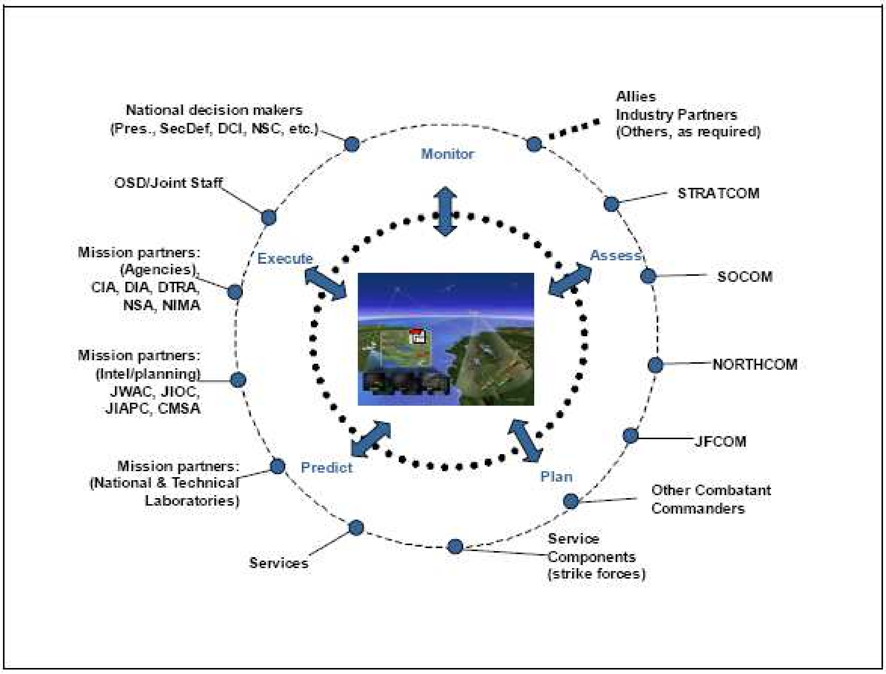
Such a system must also enable a fairly large number of actors to access the data and work collaboratively to enrich the situation. In the same way, the deep strike C2 loop should offer options for cooperative working - including data exchange and joint preparation of the general operational overview - with other systems, e.g. those dedicated to air defence and anti-missile defence[66].

[64] This may also require the public to be convinced, as was the case with American forces during Operation Desert Fox in 1998.

[65] Andrew F. Krepinevich, *Operation Iraqi Freedom: A First-Blush Assessment*, Center for Strategic and Budgetary Assessments, 2003, p. 16.

[66] This is what the Defense Science Board suggests in its 2004 report on strategic strikes, in which it makes reference to synergies between offensive and defensive components. Defense Science Board, *The Future of Strategic Strike Forces*, February 2004, p. 3-17, 3-18.

Figure 8: Sample networked command and control architecture (source: Defense Science Board 2004)



These factors demonstrate that long range strikes must be considered primarily as a complete system that includes a support component, which itself incorporates components that could contribute to other missions (e.g. data from technical sensors, intelligence or tactical scenario preparation[67]), and whose operation before and during operations significantly accelerates the decision-making cycle, improves strike effectiveness and responds to any political issues that may arise as a result.

The platform/weapon system combination is another cornerstone of the architecture: it must increasingly offer a level of performance (in terms of range, air defence penetration and warhead capability) high enough to respond effectively to a wide range of scenarios that will continue to grow over the next 15 years and to enable its use across a spectrum of varied and complex contexts: from armed conflicts to one-off and limited actions in periods of crisis. Changes in the environment and the operational context of conflicts are also likely to trigger changes in the performance required of the platform/weapon system combination and in enabling capabilities.

In light of the considerations explored above, it also seems that the deep strike function cannot ultimately be summed up solely as the acquisition of a single platform/weapon combination, no matter how effective that combination might be. The versatility required to conduct the full spectrum of missions may require an array of 'niche' assets,

[67] Ibid.

from long-range missiles fired from naval platforms, guided bombs delivered by fighter-bombers and short-range missiles launched from UAVs. The problem for a country like France is rather to achieve a financially and technically viable balance between the possession of a single system and the acquisition of the full range of assets right up to the most specialised. The primary objective here is to have the ability to address the majority of scenarios without investing large amounts of money simply to obtain capabilities whose ultimate usefulness seems marginal.

There are a number of technological, technical and operational options available for responding to the changing requirements for deep strike over the period 2020-2025.

Analysis of forward trends in the strategic context during the period 2020-2025

In gaining a clearer understanding of the factors that will structure the deep strike function over the period under consideration, it would seem helpful to conduct a forecasting exercise to identify the dominant trends and major uncertainties likely to impact on developments in the related political and operational requirements.

A number of different areas may be inherently affected by these trends and uncertainties:

Changes in the international environment could impact on types of conflict, the nature and role of those involved in these conflicts, the challenges posed by international crises and even on those regions of the world where crises are likely to develop

Additionally, potential changes in strategic alliances and/or partnerships could also have the effect of changing Western attitudes to the deep strike function, as well as options for cooperation and/or coordination on these issues. Any change in the strategic and political position adopted by Western governments could result in changing viewpoints on the role and usefulness of deep strike

Technical and technological progress could change the conditions under which force is used, for example, as a result of widespread adoption of certain defence/protection assets or refining the development of systems to make anti-access strategies more effective. Conversely, technological developments could equally facilitate certain missions or even enable system performance enhancements.

Changes in the industrial and budgetary contexts could also impact on the development or revolution of the deep strike function. Any restructuring of the industrial fabric would also be likely to bring about a change in the dependence of nation states on component and/or systems suppliers

The following table provides an overview of all those factors we have identified as likely to influence the development of deep strike capabilities. It details the dominant trends that emerge from a preliminary analysis of these factors, together with those uncertainties which could lead to divergent forward development paths.

Table 3 : Developments in the key factors influencing the requirement and operation of the deep strike function

AREAS	Dominant trends	Major uncertainties	Possible step changes
International Environment	• An eastward shift in crisis centres: ramping up of tensions in Central Asia, conflicts and crises in the China Sea and Pacific regions • Increasing economic and political competition between the two developing powers of India and China: development by China of asymmetric strategies capable of countering US military power (export of systems to customers) • Increasing numbers of proliferation crises (nuclear or biological) • Increasing piracy in the China Sea and Pacific regions, and in the major East-West sea routes (the Malacca Strait) • Sub-Saharan Africa is likely to remain an area of conflict and crisis, posing risks to our nationals and regional interests • Increasing numbers of infra-state conflicts involving an increasingly diverse range of actors (this point is further developed below) → aggravating the trend towards fragmentation of nation states • High levels of tension around deposits of critical raw materials and associated transport routes. 85% of goods transiting the world do so by sea, and 75% of this total passes through straits	• The pace and status of development in the role played by the countries of South America (especially the giant state of Brazil and the region's dynamic nations) • Risks and crises in Central America (particularly growth in criminal activities in Mexico and the rise of irredentism with the risk of contagion spreading to the US borders) • Development of Pakistan: political and strategic risks and the transition of the country to an Islamic state. Weapons security. Proliferation risks • Introduction of Asia-wide and/or regional security cooperation agreements (over shipping routes and anti-piracy, regional non-proliferation, etc.), economic cooperation agreements and space exploration and exploitation agreements • The impact of increasing scarcity of certain resources critical for external operations (water, oil, etc.) → theatre access and coverage, deployment lead times, etc. • Developments in infra-national terrorism against foreign interests • An increase in the number of state with nuclear weapons: domino effect after Iran's acquisition	• Revival of tensions in the Balkans or conflicts within Europe • War between China and the USA (over Taiwan, intervention for the benefit of India, tension in Pakistan and weapons security initiative, Korea?) • War between India and Pakistan with the possible use of nuclear weapons • Historic withdrawal of the USA to the Americas and global disengagement other than in the Pacific • Development of conflicts over control and management of 'global commons' – problems for western states in ensuring access to, and freedom of use of, these spaces (Air, Space, Sea, Cyberspace, etc.)[69]

	and/or canals (30% of all goods shipped by sea every year pass through the Malacca Strait[68]) •	• The role of private security companies in conflict management • The rise and emergence of rogue states in the ME/Asia (narco states, trafficking hubs, etc.): ratcheting effect on neighbouring countries	
Strategic relationships and alliances	• US disengagement from Europe in favour of military reconfiguration in the East against a background of defence budget cuts • Reconfiguration of the EU: Germany becomes more powerful as an economic and political leader, and the military function is vested in the UK and FR • Development of shared capabilities/EU-NATO force projection and power/crisis management: diversification of missions (humanitarian assistance, administration of grey areas, ‘policing’ missions) – possible effects of eviction on more acute military requirements[70]	• Development of US alliances in Asia: links with Japan, deployment in Korea and relations with India • Renewal (reset?) of a Russia-China-Pakistan alliance over control of the region • The economic future of Europe and political vulnerability of the European construct • The future place and role of Turkey in the Atlantic Alliance • Security coordination between Europe/NATO and Russia - or alternatively transition to a period of tension over supply issues	• A major political and economic crisis in Europe, resulting in fragmentation of the former members of the EU into multiple interest groups: western countries (FR, UK, GER, NL), southern countries, etc. • Dissolution of NATO and implementation of a European army • Emergence of a strong Afghan state and modernisation of its society to create a powerful regional ally for the West • Introduction of a security alliance in Asia, or at least an effective cooperation structure including all the major actors (Australia, China, Japan, India, etc.)

[69] On this point, see the NATO/Allied Command Transformation report *Assured Access to the Global Commons*

[68] Ibid, p. 8.

[70] European Commission, *Action Plan Implementing the Stockholm Program* (COM 2010) 171, 20 April 2010, p. 43.

Technology developments	• Development of ramjets to achieve sustained speeds of Mach 10+ • Diversification of sensor-carrying platforms: long-range UAVs, automated robots/systems, special forces unit equipment, etc. • Development of powerful automated systems for processing and merging intelligence data • Widespread use of long-distance UAVs for reconnaissance/intelligence missions • Improved performance from IR, EO and EM sensors: hyper-frequency analysis, multiband satellites, impact on self-guidance technologies? • Dissemination of powerful medium-range ground-to-air defence systems (S-300/S-400 class) - development of anti-ship capabilities • Continued dissemination of MANPADS	• Development of rapidly-deployable penetrating sensors close to targets • Development of powerful data merging software • Access to reliable and secure communication networks, global coverage and high bandwidth • The role of information systems in military operations and an increase in cyber risks for weapons systems (development of a fifth dimension for conventional conflicts)	• Space or Cyber 'Pearl Harbour': massive disruptive attack on communication and information infrastructures – priority given to protecting information systems • Increasing importance of alternative powerful weapon systems suppliers (especially China) • Development of an energy-intensive explosive military warhead (non-nuclear)
Political, industrial and budgetary factors	• Developing trend towards de-industrialisation in the euro zone → what would be the situation in France? • Cuts in capital budgets: trending towards a defence budget of 1.5% of GDP (i.e. €30 billion in 2020, including an equipment budget of €10-12 billion[71])	• Degree of weapons programme internalisation - dependence on external suppliers, visibility of component quality, options to acquire complete systems off-the-shelf, etc. • Mergers or business combinations involving European weapons manufacturers/joint development • Development of a coordinated acquisition function at European level	• Increasing incidence of economic crises and the resulting shocks for global trade models

[71] Assuming GDP growth of around 1% per year, this should reach €2,200 billion in 2020. See Guillaume Houriez, Vladimir Passeron and Adrien Perret, *Les comptes de la Nation en 2010*, INSEE Première, No. 1349, May 2011.

The nature and characteristics of future conflicts, and those of the actors that will be involved in them, are central to defining strategic strike requirements

Amongst the lessons to be learned from recent conflicts, it seems that the requirement for precision systems is not only the outcome of technological progress – which results in increasing the volume of guided strike assets relative to other weapons systems – but also the direct consequence of changes in the types of conflict engaged in by Western forces, the associated challenges and the geographic context that characterise them[72].

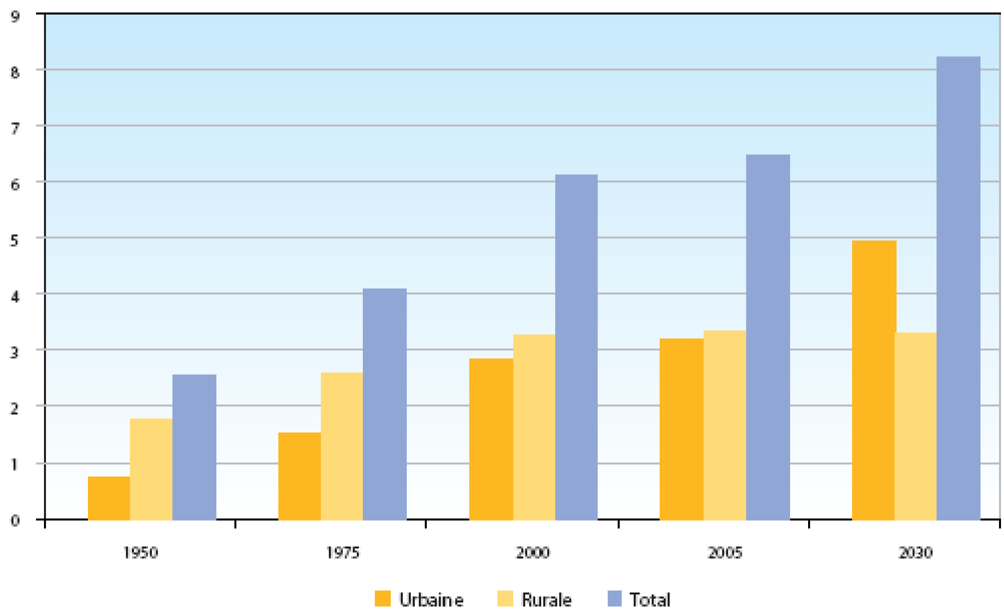


Figure 9: The urban population worldwide: projection to 2030 (source: French MoD – 2009)

Firstly, we are seeing **the urbanisation of conflicts**, which can be considered in the first instance as one of the consequences of growth in asymmetric forms of war and conflict: guerrilla actions, terrorist acts, the growth of certain forms of organized crime in failed or failing states, etc.[73]. But it also results from global demographic change, and particularly the fact that urban populations are growing. By 2030, 60% of the world's population will be concentrated in cities, compared with 49% today[74]. Added to which, both the number of megacities[75] and the size of cities are likely to continue growing over the period under consideration, further increasing the potentially urban character of

[72] Andrew F. Krepinevich, *Operation Iraqi Freedom: A First-Blush Assessment*, Center for Strategic and Budgetary Assessments, 2003, p.ii.

[73] J.-J. Patry, P. Gros, *La Puissance aérospatiale au 21ème siècle*, FRS, Recherches et Documents, 2009, pp. 17-18.

[74] Délégation aux Affaires Stratégiques, *Prospective géostratégique à l'horizon des 30 prochaines années : chapitre 5 (démographie)*, 2009, p. 161.

[75] Together containing more than 5 million people.

future conflicts and crises. Lastly, it is important to emphasise that by 2030 the majority of the human population will live near coasts or rivers. Three out of five humans already live within 100 km of a coast, and this trend seems set to increase, given the tensions we are already seeing over access to water[76].

Further conflicts between nation states are likely to focus on possession of (and access to) national natural resources, especially in terms of control over flows of materials, finance and people within and between countries. As a result, ***controlling and accessing those spaces referred to as 'global commons'*** - maritime, air, space and cyberspace - is likely to pose a critical challenge around which we are already seeing the emergence of initial strategic thinking in both the USA and Europe[77], although this thinking also extends to the concept of access that underpins Chinese efforts (for example) to exercise greater control over those spaces close to their national territory by restricting competitors' room for manoeuvre. In this regard, it would be possible, for example, to highlight the fact that the current trend amongst nation states to extend their exclusive economic areas further out to sea[78] is likely to raise genuine political issues, with the possibility of logistics and force projection issues following later. Comparable trends are already at work in space and cyberspace. The possibility of crises and conflicts developing around the issue of securing global commons and the need to protect freedom of movement and access should not therefore be underestimated.

The nature and role of players involved in future conflicts is also likely to continue to evolve in ways that give greater prominence to organisations that are further removed or even independent of nation state executive powers. It is possible that several different types of non-national organisations could play a part in future conflicts in terms, no doubt, of structuring the development of such conflicts, but without necessarily being involved as combatant forces:

⇒ **NGOs** will be drawn into playing a key role in some types of conflict involving human security, not only by complementing the action taken by external factors, but also by exercising their right to observe the conduct of conflicts and the use of weapons systems. They may also be drawn into deploying personnel in theatres of operation - sometimes intermingled with local communities - at the same time as exercising their influence at global level[79]. We are already seeing a significant increase in the number of NGOs and the resources available to them to conduct their operations, but by 2025, the figures could explode, giving these organisations a presence- en masse - in theatres of operation[80].

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[76] Délégation aux Affaires Stratégiques, *Prospective géostratégique à l'horizon des 30 prochaines années : chapitre 5 (démographie)*, 2009, p.160.

[77] The digital risks and strategic supplies sections of the 2008 *Livre Blanc* (white paper) (pp.23-27) offer a good illustration of this. See also the QDR 2010, p.iv. See also the *Délégation aux Affaires Stratégiques* report on the 30 year trend in demographic and economic factors, and its consequences for security. Lastly, the NATO *Supreme Allied Command Transformation* has published a document on maintaining access to 'global commons' in response to a series of recent events.

[78] Examples include the case of contested islands in the South East zone

[79] Délégation aux Affaires Stratégiques, *Prospective géostratégique à l'horizon des 30 prochaines années : chapitre 1 (*relations internationales*)*, 2009, p.35.

[80] National Intelligence Council, *Global Trends 2025: A Transformed World*, November 2008, p.85.

⇒ **Media** influence over world opinion should also increase in the context of conflicts over the use of new communication and information resources. Over and above the traditional actors, which take an essentially objective view of conflicts and crises, some media may adopt the viewpoint of enemies, thereby contributing to fuelling the conflict. In any event, the increasing profile of crises - and detailed information (whether manipulated or otherwise) of ongoing operations involving the use of force - is likely to continue.

⇒ **Multinational companies** will continue to see their global influence increase, accompanied by the need to ensure increased security for their assets in areas with potential for crisis or conflict. The growth in the provision of private security worldwide could benefit from the changing needs of globalised companies, especially those involved in exploiting natural resources in unstable regions. As a result, we could also see the continued rise of private armed forces companies[81] either as support forces for peacekeeping, protection and/or stabilisation duties or as direct actors in warfare against regional armed groups.

⇒ **Criminal organisations**[82] already play a significant part in conflicts inasmuch as they create greater areas in which crime can flourish (as is the case in failing states) and products and/or goods can be produced or acquired for profit: drugs, weapons etc. Their role could increase further as certain resources become increasingly rare, giving criminals the opportunity to benefit from trafficking and smuggling. Criminal networks could grow to such a size as to trigger the failure of certain nation states or trigger conflict between states as a result of the combined pressure exerted by corruption and the exploitation of the tension-generating factors specific to certain societies (ethnic, socio-cultural, religious, etc.)[83].

⇒ **Insurrectionist movements** - including terrorist organisations – constitute organised forces with the potential to define nation states and traditional powers in asymmetric scenarios, i.e. by exploiting their strengths and the vulnerabilities of the additional armed forces, and by avoiding conventional armed confrontations in which the superior arsenals and assets of nation states would inevitably result in their defeat[84]. Such movements are more likely to develop in those areas already shown to be very unstable or poorly controlled by the nation states concerned (as is the case in the Sahara and tribal areas, for example).

The crises and conflicts in which these actors could become involved would themselves be ***profoundly asymmetric in character*** and involve significant human risks for local civilian populations (and in some circumstances, even for the national security forces engaged in conflict). Examples include civil war or insurrection in the possible absence of national institutions capable of

[81] IRSEM, *Des gardes suisses à Blackwater*, May 2010.

[82] On peut inclure dans cette catégorie les organisations paramilitaires concentrées sur le contrôle de territoires et de ressources.

[83] United Nations, Eleventh United Nations Congress on Crime Prevention and Criminal Justice, *Corruption: threats and trends in the twenty-first century*, April 2005, p.9.

[84] J.-J. Patry, P. Gros, *La Puissance aérospatiale au 21ème siècle*, FRS, Recherches et Documents, 2009, pp.17-18.

guaranteeing vital national functions and services[85]. Western Armed Forces would then be drawn into extremely complex situations in which combatants and civilians are closely intertwined, the latter being used and exploited by the enemy, either in operations or for intelligence activities. We could also see an increase in humanitarian or orchestrated projections in the wake of major natural disasters, but only in contexts where security is poor or absent. It could then be a question of assisting those countries stricken by major natural or industrial disasters, keeping order in grey areas acting as trafficking hubs, or cooperating with countries as part of criminal investigations.

Even though a more general spread of this type of conflict is to be expected, especially in Africa, some parts of Asia and the Middle East, the possibility of wars erupting between nation states or the emergence of a need for intervention against stable nation states should not be ruled out.

The development of new global powers - exercising their power in military terms as well as in other areas - could lead to wide-reaching confrontations with the 'old' powers (especially the USA) over the control of resources and global commons, including those involving the flow of goods and raw materials. Wars over control of regional spaces, including sea routes, access to mineral resources and access to fossil fuels, could set major regional actors against each other (in an Asian region extending from Pakistan to Korea, the most obvious candidates are China and India) and lead to the intervention of global powers for peacekeeping missions or under the terms of alliances with one or more of the parties. More traditional in their conduct - notwithstanding the fact that some of the non-governmental actors referred to above could also play a role - these wars could nevertheless involve the use of more effective military assets with the same aim of countering the superiority of Western capability.

Chinese efforts to develop a range of weapons systems designed to neutralise some critical elements of the US military structure - aircraft carriers and high-tonnage naval vessels, submarines, satellites, information networks and communication networks - and protect China against penetration of its airspace by stealth aircraft illustrate the conditions that could characterise the sequence of events in a regional conflict between nation states[86].

One-off and time-limited interventions will also remain a possibility in response to recognised risks of proliferation, for example, even though the powers concerned may not deploy significant military assets. They could, for example, take the form of raids against installations seen as threatening international security or the security of neighbouring states, or that of targeted operations against the heads of criminal/terrorist organisations sheltering in outlaw localities. Over the time period under consideration, it is likely that the risks of proliferation (essentially nuclear or biological) will not be under sufficient control for this type of need to disappear completely. Despite the prevention efforts made, states entering the proliferation arena - or even non-governmental

[85] OECD, *Future Global Shocks: The Risk Landscape*, April 2010, pp.31-32.

[86] There are many Anglo-Saxon publications addressing this issue. Examples include the annual report of the US Department of Defense (DoD) to the Senate on Chinese security capabilities. Office of the Secretary of Defense, *Annual Report to Congress on Military and Security Developments Involving the People's Republic of China*.

actors - could achieve levels of competency advanced enough to warrant the use of force.

Taking all these factors into account, it is possible to come to the overall conclusion that future conflicts will take place in contexts that are extremely restrictive from several points of view:

⇒ ***In humanitarian terms***, due to the urbanisation of wars and the intermingling of some competence with civilian populations. Conflicts could also be triggered by direct involvement of ethnic or religious groups or even population groups living in areas close to those that aggressors wish to acquire.

⇒ ***In operational terms*** for those crises or conflicts involving major regional powers inasmuch as they will probably possess weapons systems suited to area denial and anti-access operations within the time period under consideration. The spectrum of missions that Armed Forces will be called upon to conduct - including one-off operations against WMD in remote/inaccessible areas or counter-terrorism operations - should also continue to grow[87].

⇒ ***In media terms*** - and consequently from a legal point of view - it will be important to take account of the involvement of many non-governmental actors, who will demand levels of security compatible with delivery of their missions. Whether as observers or participants, they will lose no opportunity to report the facts, but will also demand that Western forces maintain faultless compliance with standards, especially in terms of the laws of war. The pervasive presence of the global media - some of which will be potentially hostile - will impose significant pressure on battlefield military command units.

Developments in French deep strike requirements for the period 2020-2025.

On the basis of the key factors influencing deep strike requirements shown in Table 1 and discussed in the previous chapter, we believe it possible to draw a number of conclusions regarding the factors that will contribute to structuring future deep strike capability for the period 2020-2025:

⇒ ***Access to theatres of operation will prove more complex overall*** than is the case today, even in situations where the enemy is located in areas that are easy to access and has no sophisticated defence systems left in operation. In reality, we risk seeing crisis zones moving further east, and particularly the region surrounding the China Sea[88]. The development by emerging powers and their allies of anti-access capabilities - including anti-ship assets capable of threatening large warships[89] - is likely to force their adversaries to launch power projection operations from relatively distant areas in response to the need to

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[87] Délégation aux Affaires Stratégiques, *Prospective géostratégique à l'horizon des 30 prochaines années : chapitre 1 (*relations internationales*)*, 2009, p.52-53.

[88] Hillary Rodham Clinton, *America's Pacific Century*, Foreign Policy, October 2011.

[89] Cf. The development by China of the DF-21D anti-ship ballistic missile, with an estimated range of approximately 2,500 km, and the modernisation of submarine warfare capability by China and Iran. See: Mark Stokes, *China's Evolving Conventional Strategic Strike Capability*, Project 2049 Institute, 14 September 2009.

keep ships and/or vulnerable support assets out of the range of anti-ship and/or anti-air capabilities. American thinking on strategic strike capability is therefore moving towards the development of a bomber with an operating range of approximately 4,500 km[90].

⇒ Although this region is not likely to be one of the priority areas in terms of French interests, the emergence of China as an exporter of weapons systems - to countries that have not traditionally been customers of the West for security reasons - could nevertheless broaden the overall risk of anti-access, including in theatres closer to Europe. In this way, countries like Iran may look to modernise their anti-ship and air defence assets[91] and could find China a more accessible vendor, not only in terms of hardware, but also in terms of technology and skills transfer.

⇒ The more widespread introduction of anti-access and zone denial strategies and assets could also lead to the need for increased penetration capability from the effectors and platforms intended for deep strike operations. Similarly, the range and, possibly, endurance of the platform/effector combination[92] may be affected by the need to conduct conflicts against countries with relatively sophisticated anti-air capabilities and significant geographic depth[93].

⇒ ***Proliferation crises are likely to increase in the coming decade*** with, on the one hand the increasing importance of the Iranian nuclear programme, and on the other, the foreseeable destabilisation or fragmentation of the situation in Pakistan. The possibility that, in the context of a crisis of conflict, the need may arise to neutralise enemy non-conventional capabilities for counter-proliferation purposes must be envisaged and could be a determining factor in terms of dimensioning systems performance. It is important to remember that neutralising weapons of mass destruction and their delivery systems - especially when nuclear weapons are concerned - raises a number of specific difficulties:

- The effects of contamination on the environment and populations may be considerable: methods of action should therefore be adapted to minimise these effects or even avoid them completely. This requirement is even more important where there is a need to neutralise a large number of installations or weapons presenting significant collateral risks.

- The need to succeed in effectively neutralising target may be crucial if a particular weapon is on the point of being used against our forces or populations, or those of our allies. As a result, this requirement highlights the criticality of the entire intelligence cycle, including damage evaluation once the operation is underway. This must be fast enough and accurate enough to enable re-engagement of the target if necessary, or to take additional

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90 Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, pp.32-34.

91 As demonstrated by the agreement with Russia for the sale of S-300 missile systems blocked as a result of Israeli pressure in 2010.

92 In the sense of 'loitering', i.e. the capability to hold station above the target in terms both of endurance and degree of resistance to air defence assets.

93 Le cas iranien vient à l'esprit dans ce contexte. Ibid, pp.15-16.

measures to reduce the potential damage of weapon use. But above all, detection of the risk of use, the identification of a possible weapon location, the confirmation of weapon existence, the risk of its use and its tracking[94] are fundamental requirements in terms of security, and for deep strike effectiveness. Confirmation of the risk that a weapon may be used may also be necessary from the legal point of view if the use of preventive force must be justified under international law by recourse to Article 51 of the United Nations Charter (legitimate defence).

In practice, these constraints will also be heightened by the probable increase in passive protection measures put in place by future enemies to frustrate surveillance capabilities and conceal the deployment and use of their military assets, especially non-conventional assets. The intelligence gathering architecture will therefore be confronted by situations in which the existence or even location of a weapon of mass destruction in a given area will be identified or confirmed only a very short time before it is used.

There are other scenarios in which the time constraint, although less pronounced, may also impact negatively on the deep strike function. In this way, neutralisation of a fissile material production capability must be achieved as quickly as possible in order to avoid its commissioning or operation[95]. The complexities surrounding timing are accompanied by the fact that neutralisation of a mature programme[96], in which the industrial components are distributed over an extensive geographic area, may require considerable strike assets (including the number of carriers used simultaneously) and intelligence assets.

⇒ The possibility of a gradual withdrawal (but under no circumstances a total relinquishment) by the USA from European security affairs should also lead Europeans towards choices in terms of deep strike architecture, especially in relation to crises occurring within its own security space. Although a scenario in which NATO ceases to assist is not yet on the agenda, there is every reason to doubt the ability of the European Union countries to provide joint funding and development for the implementation of a future capability. Recent conflicts have demonstrated the existence of a certain level of dependency amongst the

[94] Particularly for the neutralisation of mobile launch capabilities, which should be the focus for nation states seeking to protect their assets against possible preventive actions. Cf. Arms Control Wonk, "DPRK Road Mobile ICBM", 5 October 2011.

[95] The example of the Osirak reactor in Iraq in 1981 or the Al Kibar reactor in Syria in 2007. The internal debate that surrounded the latter case within the US demonstrates the full complexity of the decision-making involved. The leading *Arms Control Wonk* blog has an article on this subject, the main purpose of which is to clarify the position adopted by various American parties responsible. In addition to the fact that it seems the reactor was not in operation, which led the President to veto the use of force, it should also be noted that: *"Cheney does not reveal that then-CIA Director Michael V. Hayden had a team working for months to examine the intelligence on the Syrian reactor."*. Arms Control Wonk, *Revisiting Bush's decision on Al Kibar*, 12 September 2011.

[96] Moreover, the dispersal of programme technical capacities is also part of a strategy to avoid its neutralisation by military action.

countries of the Alliance, including France and UK, on the intelligence contribution of sensors[97].

⇒ In the absence of a joint effort - in which engagement is made all the more uncertain since budgetary projections that will impact significantly on European budgets and since the efforts of the EDA have not yet been sufficient to enable the definition (much less a European programme) - it is hard to believe that Europe will have the assets required to undertake an operational spectrum as wide as the changing missions could require within the time period under consideration. However, it would be possible to envisage that technical and technological progress in terms of effectors, sensors, platforms[98] and data processing resources could close the gap in terms of some of the current shortfalls in capability. Under these circumstances, the cost of developing and producing intelligence gathering and processing assets could fall sufficiently to facilitate European acquisition of a broader spectrum of capabilities and those which the various European nations currently possess.

⇒ The role played by IT resources in future weapons systems is likely to be large enough to increase the vulnerability of military systems to digital attack, and in a wider sense, to electronic warfare operations. The emergence of a fifth dimension of military conflict in the shape of cyberspace could prove to be a significant trend leading to the partial remodelling of how operations are conducted[99]. Although this trend does not influence operational requirements directly in terms of deep strike, it is nevertheless likely to change the architectural constraints indirectly[100].

- o The case of the *Conficker* worm that infected the Navy information system and resulted in it being quarantined[101], illustrates the risks involved in computerising weapons systems. More recently, the infection of the US REAPER and PREDATOR UAV operating system by a keylogger demonstrates the vulnerability of missions to IT actions designed to gather information[102]. Inasmuch as future deep strike capabilities will depend on the performance of C2 systems, the issue of their digital security merits

[97] Philippe Gros, *Quelles leçons pour les forces armées après les opérations en Libye*, Club Athéna, fiche thématique N°7, Octobre 2011. The author places particular emphasis on the current inability of the armed forces to achieve dynamic targeting of time critical targets without access to sufficient capacity in terms of sensors and intelligence data interpretation.

[98] Especially in terms of non-piloted aircraft.

[99] The emergence of this fifth dimension has resulted in the Pentagon bringing together all digital activities under the responsibility of a single command structure reporting to STRATCOM. Created in May 2010 and reporting to the Head of the NSA, Cybercom is tasked with coordinating the armed forces' offensive and defensive efforts in the digital space. Center for New American Security, *America's Cyber Future: Security and Prosperity in the Information Age*, Edited by Kirstin Lord & Travis Sharp, June 2011, pp.32-33.

[100] The Red Flag exercises conducted by the USAF to prepare young pilots for future combat missions include elements of electronic and IT warfare. See: Jane's International Defense Review, *Flying the Flags: USAF's training exercises adapt to new threats*, 11 October 2011.

[101] http://en.wikipedia.org/wiki/Conficker

[102] RIA Novosti, *Virus Hits US Drones Control System*, 9 October 2011. See also the excellent article in WIRED on this issue: http://www.wired.com/dangerroom/2011/10/virus-hits-drone-fleet/

examination in order to avoid the possibility of IT attacks paralysing or slowing the cycle of engagement.

Table 4 : Illustration of the development costs and performance of some US deep strike options (sources : CSBA, CRS, DSB)

DELIVERY SYSTEM	FLIGHT TIME	RANGE CATEGORY	DEVELOPMENT LEAD TIME	DEVELOPMENT COST	PAYLOAD CATEGORY
Ballistic Missile (conversion)	*30 min +*	*10,000 km*	*Near term*	*$500 million*	*500 kg*
Specially designed ballistic missile (CSM, SLIRBM)	*20-30 min*	*5,000-10,000 km*	*2015*	*$2-3 billion*	*1,000 kg*
Boost-Glide	*20-45 min*	*10,000 km*	*2020-2025*	*$7-10 billion*	*1,000 kg*
Hypersonic cruise missile	*30 min +*	*5,000 km*	*2025*	*$7-10 billion*	*500 kg*
Strategic Bomber (Successor to the B2)[103]	*5 hours+*	*5,000 km (without refuelling)*	*2020-2025*	*$10-20 billion*	*10,000 kg*
Combat UAV (X-47B type)	*5 hours+*	*4,000 km*	*2015-2020*	*$2-3 billion*	*2,000 kg*
Long-range/ reprogrammable cruise missile (Tomahawk successor)	*1 hour+*	*>, 000 km*	*2015*	*(unit cost ~$1 million)*	*500 kg*
Energy weapons	*A few seconds/ minutes*	*N/A (probably less than 1,000 km)*	*2025+*	*$20 billion*	*N/A*

⇒ In any event, budgeting for future deep strike capability may prove complex for European countries in general, and France in particular. The fact is that those solutions that could potentially respond to the requirements identified come at relatively high cost, with the exception of the effector element. So in the context of the American strategic strike debate - which focuses both on replacing the bomber fleet and on deep strike options - the broad range of options under consideration range from a few hundreds of millions (for solutions based on the conversion of existing ballistic missiles, which comes with all the strategic difficulties associated with the use of these devices) to several tens of billions (for the development of a new strategic bomber). These estimates undoubtedly exclude the cost of developing and acquiring the environmental components vital for operation of a deep strike system.

- Neither Europe, nor especially France, could envisage development of such a broad range of technical solutions, and the choices made will very probably

[103] Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, pp. 61-62.

be based on considerations such as architecture versatility, i.e. the capability to address the widest-possible range of scenarios.

- In addition to the issues surrounding funding, the problem of gaining secure access to certain technologies, components and systems could arise within the time period under consideration, depending on how the industrial fabric of the European Union develops. At present, France has the required scientific and industrial capability in some key areas[104]. However, this situation is not set in stone, and may develop to a position of dependency on countries outside the euro zone, especially the USA.
- The option of European cooperation over long range strike capability is not a possibility without a minimum level of consensus on the conditions under which that capability could be used. The fact is that there appear to be many different viewpoints on this issue within Europe at the current time.

⇒ In theory, France could envisage limited use of this capability against targets of high political value, which would require a decision-making chain leading ultimately to the head of state. However, a number of considerations contradict this theoretical reading of the situation:

- Firstly, the size of the cruise missile arsenal is more consistent with a hybrid positioning than a deliberate choice between strategic capability and tactical use: the number of devices available is too large for extremely occasional use (e.g. for a decapitation mission in an enemy state), but is too small to pursue lengthy and asset-hungry operations (e.g. SEAD), except where the enemy concerned possesses only reduced anti-air capabilities.

- Furthermore, the SCALP weapons system seems to have been used on several occasions against targets of military value, but whose political and strategic value were below the level that could be considered as typical for possible targets, given the posture adopted[105]. For example, the Libyan mission was one of those circumstances in which American forces were delegated with decision-making power on behalf of the executive. Similarly, the use of Storm Shadow by the Royal Air Force seems to have been governed by conditions relatively similar to those applied to the use of the Tomahawk Land Attack Missile (TLAM) by the Royal Navy and US Navy against military targets[106].

⇒ Germany is likely to find itself with a theoretical model similar to that of France, that is to say occasional strategic use of its deep strike capability, which is based on the Taurus cruise missile. However, the number of systems ordered seems more suited to a pattern of usage similar to the British model: more operational in nature and directed against military targets.

[104] Examples include air-breathing propulsion (Microturbo) systems and the work being done on hypersonic rocket motors (http://www.onera.fr/conferences-en/ramjet-scramjet-pde/).

[105] http://www.marianne2.fr/blogsecretdefense/Libye-premier-tir-operationnel-d-un-missile-de-croisiere-Scalp-par-la-France_a189.html

[106] http://www.mod.uk/DefenceInternet/DefenceNews/MilitaryOperations/RafConductsPrecisionStrikesOverLibya.htm

⇒ Spain, which has ordered only a small number of these German missiles, seems to adopt a position based primarily on complementarity with the existing assets of other allies, rather than one designed to have the option of conducting deep strike operations alone.

On the basis of these examples, which demonstrate the absence of coherent thinking between European nations regarding a policy for using deep strike capabilities, it seems that there probably is a general consensus on the (political, strategic and/or military) usefulness of cruise missiles. This minimum level of agreement is required before embarking on any shared acquisition commitment regarding the SCALP/Storm Shadow. On the other hand, the consensus does not seem strong enough to unite all the partners around a shared operational requirement, which could include a commitment to a single weapon for the full range of different platforms.

Considerations regarding technical solutions and architecture options

Those technical solutions that could be considered for the purpose of meeting future deep strike requirements focus simultaneously on effectors, the entire processing loop and the command and control cycle. In general terms, it would seem helpful to take the view that certain missions - which, as we will see, can be considered as more or less indispensable - can be undertaken only if the entire system achieves certain levels of performance.

As we have seen, it is possible to identify two key components of a deep strike system, each of which may encompass multiple functions, the effectiveness of which governs (to a greater or lesser extent) the performance of the entire system:

⇒ ***Dedicated effectors and carriers***: there is no shortage of possible combinations within the spectrum that extends from silo-launched ballistic missiles to short-range missiles launched from an armed UAV. Naturally, choices will depend on the types of mission adopted, the constraints/conditions applying to use and, in some cases, external political, industrial or budgetary/financial considerations. This combination will determine (or at least influence) a number of key system capabilities, including range, enemy airspace penetration capability, flight time to target and accuracy.

⇒ From the technical point of view, the various solutions cover a very broad range of performance and cost, as can be seen from Table 2. The options adopted by France on the basis of using cruise missiles launched from combat aircraft and, eventually, submarine-launched air-breathing delivery vehicles already meet the majority of the requirements discussed above. Nevertheless, technological gains will be crucial in responding to the foreseeable development of threats (whether ground-to-air or anti-ship assets) and the emergence of specific requirements (e.g. in terms of flight duration). The following table uses a number of operational requirements to demonstrate that the range of requirements is broad enough to justify new developments in system architecture.

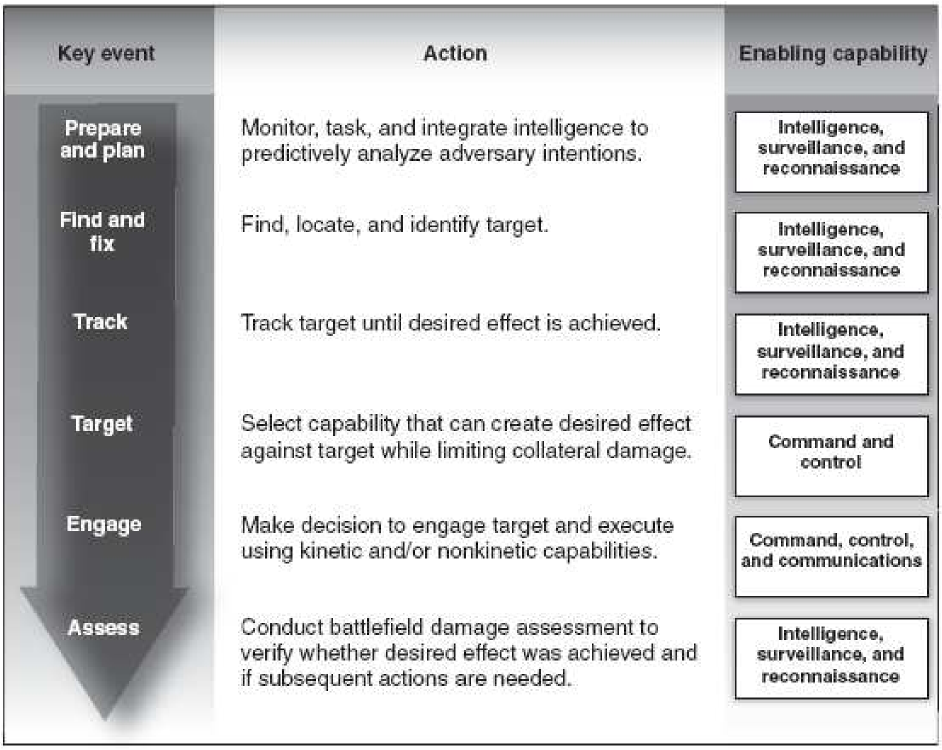
Table 5 : Illustration of requirements analysed by phase of use

PREPARATION	PLANNING	USE/IMPLEMENTATION	DESIRED ULTIMATE PERFORMANCE	NOTES
Target data (IR/EM signatures, interment and hardening levels, position, 3-D form, etc.)	Catalogue of targets with data and characteristics (not limited to data from airborne/space assets)	Damage evaluation/BDA (real-time, post-event, accuracy and verification)	Speed, range and flight time	Issues of cost and affordability
Target environment data (defence systems along the flight path, target defences, immediate physical environment, etc.)	Possible access paths (including 3-D mapping, digital imagery of the target, GPS data, etc.)	In-flight (re)programming of effectors and/or platforms	Penetration (speed, stealth, flight altitude, countermeasures, etc.)	Complementary assets (special operations)
Securing of communications (between operational units, with politicians, with the platform, etc.)	Catalogue of ground-to-air threats (with characteristics and frequently updated)	Launch platform performance data/characteristics	Accuracy and flight profile	
Command and control loop (launch/recall orders, reports, shared situation, etc.)	Documentation on the environment and situation of areas and nation states	Size of arsenal - size of salvos	Target zone loitering	
Coordination with other assets and operations (especially CAS, but air support generally)	Analysis of strike related risks	Surveillance of targets (persistence) and (timely) distribution of data in C2[107] → shorter sensor/firing times		

⇒ ***The role played by enabling capabilities*** is often underestimated by observers, experts and, to a degree at least, by those responsible for leading capability implementation. In an audit of the CPGS programme conducted by the Government Accountability Office in 2008, the GAO notes that although the requirements for effectors were relatively well identified and that the work required to meet those requirements was structured, the same could not be said of environmental asset development, which was found to be much less satisfactory. The report also emphasised that: *"DOD (...) has not fully assessed the requirements or coordinated improvements for related enabling capabilities that are critical to the planning and execution of successful global strike operations with the potential offensive systems it intends to develop."*[108]

[107] Andrew Krepinevich, *Operation Iraqi Freedom: A First-Blush Assessment*, Center for Strategic and Budgetary Assessments, 2003, p. 14.

[108] Government Accountability Office, *Military Transformation: DoD Needs to Strengthen Implementation of Its Global Strike Concept and Provide a Comprehensive Investment Approach for Acquiring Needed Capabilities*, April 2008, p.5.



Source: DOD.

Figure 10: Environment assets employed at different phases in the use of deep strike (source: GAO – 2008)

⇒ Part of the problem here is undoubtedly that intelligence capabilities are developed independently inasmuch as the resources and assets involved serve a broad spectrum of operational and political requirements. There is also a basic problem with funding and managing data gathering and processing programmes as a result of the fact that responsibilities are shared between armed forces and intelligence agencies[109]. The classification often inherent in projects conducted by the services can result in significant problems in terms of taking account of all those requirements that really should be taken into account. Conversely, we observe that the overall performance of the architecture underpinning the deep strike function undoubtedly relates more to the ability to integrate intelligence into the decision-making and preparation loop than to sensor capability.

Considerations regarding the platform/effector combination

There are a number of technical available that could respond to the various requirements and the way in which they may develop in terms of delivery systems and platforms used to carry and launch them. Outside the USA, those countries wishing to have such a capability generally choose one or two options, depending on the type of mission they

[109] The US case is fairly well documented, but it would be fair to assume that the conclusions drawn probably apply more generally to our own architecture. See: Government Accountability Office, *Intelligence, Surveillance, and Reconnaissance: DOD Can Better Assess and Integrate ISR Capabilities and Oversee Development of Future ISR Requirements*, March 2008.

have in mind. Israel, for example, focuses this function on piloted aircraft carrying guided bombs designed to penetrate enemy airspace, whereas the UK and France prefer a solution based on the use of cruise missiles launched from airborne or naval platforms outside the sovereign of the target country (EEZ or airspace).

The choice of carrier and launch platform depends on the mission, i.e. the geographic region concerned and the type of action envisaged. In some circumstances, particularly in distant areas where the military footprint is small[110], Navy ships come into their own, including their role as a base for the possible use of naval air assets. Where the anti-ship threat is prevalent, or even where surprise attack is the preference - e.g. to attack time-critical targets - the choice may focus more specifically on submarines carrying suitable effectors.

Over and above mission-specific imperatives, the intrinsic performance of platform alternatives must also be taken into account. This way, the carrying and firing capability will determine the volume of effectors that can be employed against a given target at a given time or throughout a campaign.

Surface vessels seem generally to be the most likely carriers, with the ability to fire a significant number of weapons simultaneously. US Arleigh Burke class destroyers carry a 96-cell Mk 41 vertical launch system, whilst Ticonderoga class cruisers carry a 122-cell system. By way of comparison, a Virginia class fast attack submarine carries a 12-cell launch system capable of firing TLAMs. European naval vessels are generally smaller in size, a factor that is reflected in their firepower: the future French multirole frigates can carry 16 naval cruise missiles[111], and the British T45 class destroyers have a theoretical capability to launch around 40 cruise missiles[112].

Combat aircraft are generally even more constrained in terms of carrying capability. With the exception of US bombers, which can carry several dozen bombs with warheads of differing sizes[113], the majority of aircraft can carry only a few weapons. The Rafale has 14 weapons payload hardpoints and the Tornado up to 10. In practical terms, these small aircraft can usually carry a cruise missile, and are therefore more suitable for raids requiring limited quantities of weapons and/or closer proximity to the target before firing the effector.

At this point, it may be helpful to identify three main categories of solution relating particularly to the effector segment:

⇒ These deliver high performance in terms of flight speed and airspace penetration at the same time as avoiding any need to risk the lives of users, but are restricted to carrying lightweight warheads and can achieve only now levels of accuracy. The great majority of these solutions are based on the use of an air-breathing

[110] No opportunity to deploy forward ground bases in areas far removed from the homeland.

[111] http://www.defense.gouv.fr/dga/equipement/naval/la-fregate-multimissions-fremm

[112] If we assume that the Sliver and Mk-41 vertical launch systems are roughly the same physical size.

[113] Up to around 20 tonnes for a strategic bomber. The considerations surrounding future requirements could result in a reduction in the quantity of weapons carried for reasons of program funding and, eventually, operational readiness. Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, p.61.

vehicle, whether a cruise missile or booster-glider solution, such as that envisaged by the USA in its HTV programme[114].

⇒ Performance gains will undoubtedly be made during the coming years, with the emergence of high-performance ramjets and continued improvements to navigation and terminal guidance systems. We can therefore hope to achieve effectors delivering speeds of around, or even in excess of, Mach 10, and target accuracy of around 1/10 of a meter or greater. However, the warheads carried are likely to remain in the hundreds of kilograms.

⇒ The use of ballistic missiles - whether converted nuclear systems or new vehicles designed specifically for conventional missions - raises a number of political difficulties. The specific risk of a firing being misinterpreted by nuclear power has led the American authorities to definitely reject this option, despite the fact that it offers useful performance that responds effectively to some operational requirements. Technically speaking, and excluding solutions based on a manoeuvrable re-entry vehicle, these effectors cannot be expected to deliver levels of accuracy compatible with deep strike missions as defined on the basis of the preceding needs analysis. The lack of targeting accuracy therefore reduces the usefulness of this type of system – or at least the use of converted nuclear delivery systems – to attack complex (relocable, time-critical, interred or even hardened) targets[115]. Even if there are solutions to counter this problem, they prove to be costly and difficult to develop in technical terms.

⇒ At this time, there seem to be two particular solutions in terms of effectors of this type:

- A hypersonic glider positioned using a space launch vehicle, which could reach its target at speeds of approximately Mach 20. Such a system could also manoeuvre in the atmospheric phase of flight and therefore correct its trajectory to increase its terminal effectiveness. However, attractive as it is, this solution is demanding not only technically, but also financially: the difficulties reported by the Defense Advanced Research Projects Agency (DARPA) with the Hypersonic Technology Vehicle program – the most recent of which was in August 2011[116] – are hardly surprising and demonstrate that this can never be a straightforward development.

- The development of a supersonic cruise missile is one of the most effective solutions for the future of deep strike capabilities. Without necessarily seeking to achieve the speeds envisaged by the USA for its Hypersonic Cruise Missile Project (around Mach 8), the development of a system capable of maintaining Mach 3-4 for a relatively long period, and thereby delivering ranges of between 1,500 and 2,000 km could provide the reach required to strike in geographically distant areas and penetrate dense, high-performance

[114] This range of solutions also includes the use of ballistic missiles.

[115] Austin Long, Dinshaw Mistry, Bruce M. Sugden, *Going Nowhere Fast: Assessing Concerns About Long-Range Conventional Ballistic Missiles*, International Security, Spring 2010.

[116] Noah Sachtman, *Pentagon's Mach20 missile lost over the Pacific – again*, WIRED, 11 August 2011.

air defences[117]. As with the previous solution, this option is costly – especially when compared with the savings possible with more basic systems[118] – and its development period will probably be a long one, with operational deployment possible at somewhere around 2025, according to American studies[119]. A convergence between strategic systems and conventional assets could be considered, and indeed already exists in terms of platforms, which offer dual capability in terms of missions.

- The revolution of current cruise missile configurations should enable performance increases in certain key areas – especially as a result of the possible addition of an in-flight reprogramming capability or the development of 'loitering' solutions, whether missile-based or otherwise – whilst at the same time, we must expect that the costs of acquiring and using these vehicles will reduce as a result of manufacturers making use of well-established technologies (especially in terms of air-breathing propulsion systems). In financial terms, we could even envisage the unit price of weapons falling as a result of choosing to give effectors a shorter range[120]. However, such a choice would increase the exposure of platforms and their operating crews, which may seem injudicious given the foreseeable development of anti-access and area denial assets, unless the need for penetration and survivability of future platforms is further advanced[121].

- The development of a generation of supersonic cruise missiles is not, however, likely to result in any fundamental change to concepts of usage, but should lead to a marginal improvement in the ability of these systems to deliver a broader range of missions. A capability based on cruise missiles should therefore consolidate its complementary status with, on the one hand, 'traditional' bombing options and, on the other, the use of tactical assets for air-ground support operations. However, and more importantly, it remains a unique asset for attacking high-value targets, which also justifies possession of only a limited number of high-performance systems (including the aim of achieving speeds very close to, or slightly in excess of, Mach 1), rather than an equivalent quantity of other precision weapons.

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117 Notwithstanding the fact that S-400 and similar assets will be commonplace in the time period under consideration.

118 cf. below.

119 Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, pp.36-37. Nevertheless, we observe that the levels of funding currently allocated to the various options for future effectors do not enable rapid development.

120 Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, p.71.

121 An assumption that could be considered for a future generation of fighter-bombers, possibly based on unmanned combat air vehicles (UCAVs).

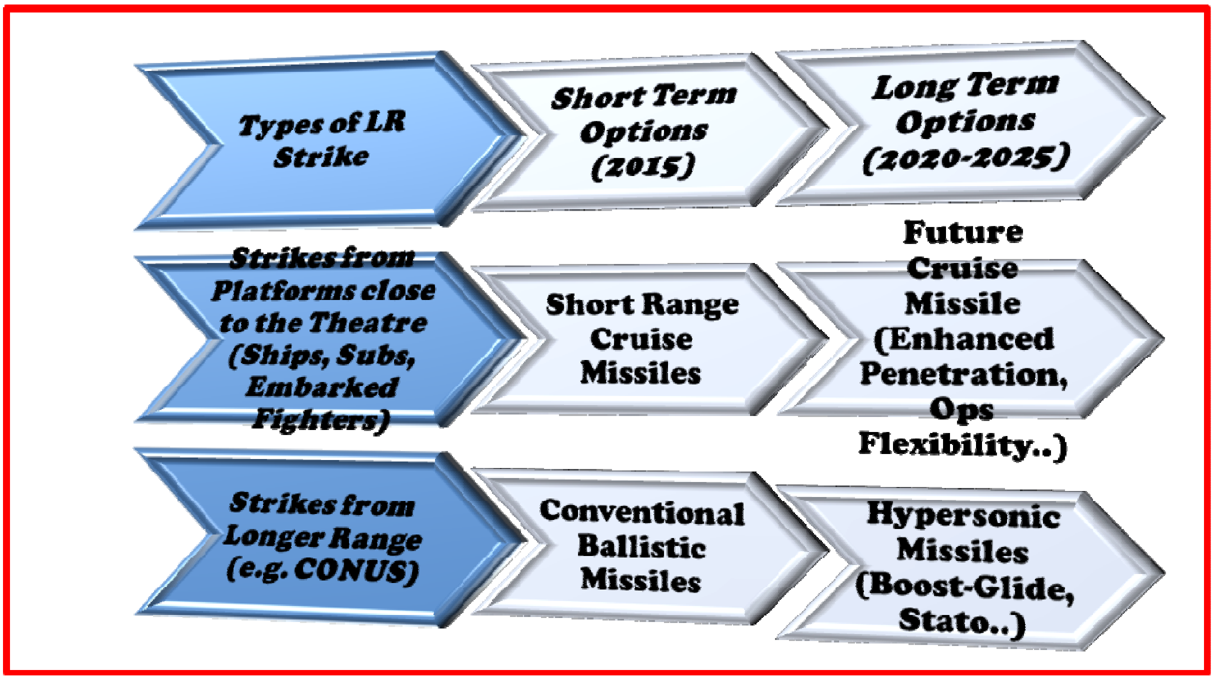

Figure 11: Three deep strike options and their development in the period 2020-2025.

⇒ The last of the possible options consists of transferring effector penetration and survivability requirements to the platform, and using the latter for the deployment of short-range or very short-range delivery systems. This solution, which is based on the use of an aircraft or, in some cases, a deployed ground force[122], offers the benefit of inherently better room for manoeuvre in terms of the quantity of 'payload' used.

The choice of such an option may be relevant in two types of scenario:

- The first is a scenario where air superiority is established and/or the aircraft or ground forces can operate with virtual freedom without fear of being engaged by enemy forces. This scenario could also apply where the platform is a surface vessel with the ability to position itself close inshore to attack targets relatively close to the coast. In this case, the use of a dual-purpose anti-ship/ground attack effector could be considered as part of the overall engagement framework. This type of context would provide the capability to attack a broad spectrum of targets within a relatively short time with a wide range of effectors and platforms, assuming, of course, that sufficient technical data and intelligence are available to enable these targets to be engaged effectively without the risk of collateral damage.

- The second option is a scenario in which one or more targets are attacked in an area defended by air defence systems of greater or lesser sophistication, the most difficult challenge being posed by medium-range assets such as the S-400 (and potentially the S-500 at a future time) and short-range systems like the Tor-M1, etc. This type of configuration is the one adopted by the

[122] At the limits, this may involve troops being present in, or projected into, the target area.

Israeli authorities for counter proliferation strikes like those against Osirak and Al-Kibar, and in defence environments offering few constraints to the aircraft deployed to deliver the strikes[123]. In addition to the fact that aircraft and crews must be able to operate on the basis of complex flight plans, this solution does not seem applicable in circumstances where a large number of coordinated strikes must be delivered in parallel (typically as part of enemy air defence suppression operations, for example).

The outlook for environment capability development

Intelligence, surveillance and reconnaissance: the outlook for development

As we have seen, the development of intelligence, surveillance and reconnaissance assets is critical for effective operation of deep strike assets. This system must fulfil multiple functions, ranging from target detection to strike outcome evaluation. It is therefore in use at every stage of a prompt strike operation and supports the actual effectiveness of that operation, especially where difficult targets are concerned: unique[124], time critical, protected or camouflaged.

In its report of 2004, the Defense Science Board defines ISR as: "(...) hardware and software systems of sensors, data collectors and platforms, and the exploitation tools needed to extract information from the data"[125]. So in addition to sensors, dedicated platforms and data interpretation assets must also be included when considering environment capabilities.

The systems involved in intelligence, surveillance and reconnaissance are as follows:

⇒ ***Imaging assets*** designed essentially to characterise a target and its environment from the technical point of view: they supply data that can be used (after processing) as direct input for the self-guidance unit(s) of the weapons systems used in terms of infrared, radar and electro-optic signatures. Capable of achieving high levels of geometric resolution (to the nearest metre, or even more accurately in the case of certain systems) and access to an increasingly broad spectrum of frequencies (and in certain cases to hyper-frequency capabilities[126]), they also enable precise mapping of the target environment and supply the geo-referencing data crucial to targeting[127].

Imaging, and particularly spatial imaging, can also provide intelligence on changes occurring in an area within a given timeframe. Re-imaging within a few

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[123] Anthony Cordesman, *The Israeli "Nuclear Reactor Strike" and Syrian Weapons of Mass Destruction: A Background Analysis*, Center for Strategic and International Studies (working draft), 24 October 2007, pp.5-6.

[124] i.e. Those targets that have not been characterised in advance or are located in areas not covered by a target dossier. Cf. §1.2.

[125] Defense Science Board, *Future Strategic Strike Forces*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, February 2004, p.3-1.

[126] This enables improved characterisation of targets and their environments. Fondation pour la Recherche Stratégique, *Utilisation des techniques d'imagerie et de transmission spatiale pour la sécurité civile*, 12 June 2009, p.25.

[127] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p.52.

hours may reveal the appearance or emergence of targets previously unseen. It should be noted however that exploiting imaging data (from satellites or other sources) requires considerable human input in order to be of practical use[128]. The automation of certain IT processes (object recognition, firings on characterisation, etc.) is foreseeable in time, but sufficiently accurate systems are unlikely to be developed operationally for several years. The possibility of obtaining a virtually uninterrupted flow of real-time images (and potentially multi-spectral images) using airborne solutions – notably high-altitude/long endurance UAVs or piloted aircraft (AWACS or similar) – is proving to be useful for the surveillance of areas with short re-imaging times[129] and provides a higher level of geometric accuracy that can be obtained with satellites.

⇒ ***Airborne sensors*** (piloted or non-piloted) have been effective in reducing average air support operation engagement times in recent conflicts: from the several hours required in 1999, only a few minutes are needed to engage a time-critical target in Afghanistan today[130].

Nevertheless, shortening the time between target detection and attack by effectors relies on the relatively permanent presence of airborne assets above the combat zone, and is therefore reliant on the absence of any serious/modern surface-to-air defence threat or effective camouflage/countermeasures. In a scenario characterised by enemy use of anti-access or area denial assets - which is the benchmark scenario for the future, as we have seen in the case of a conflict in Asia or even certain parts of the Middle East - it is unlikely that UAVs operating at medium altitude or even certain types of piloted aircraft could fly effectively without exposure to risk[131]. Similarly, enemy use of countermeasures - whether simple or complex – to evade airborne or satellite sensors or to give the impression of undesirable collateral effects would seem to be sufficient to reduce considerably the effectiveness of this data-gathering resource. Lastly, as highlighted in one of the reports published by the Defense Science Board, UAV on-board sensors do not supply a sufficiently high level of geo-reference in accuracy for compatibility with the processing required for certain targets[132].

The use of UAVs also requires the presence of a ground or airborne command and control infrastructure - in line of sight of the aircraft or in contact with it via a satellite link - capable of receiving relatively high data flows, with the option of transmitting those flows to ground-based relay stations for onward transmission to processing and analysis centres.

BDA missions are particularly important in the context of identifying the need to re-engage a target that has not been destroyed (sometimes within an even more

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[128] Ibid.

[129] Which varies depending on the size of the area, but may be assumed to be approximately one hour for the purposes of illustrating this point.

[130] Andrew Krepinevich, *Operation Iraqi Freedom: A First-Blush Assessment*, Center for Strategic and Budgetary Assessments, 2003, p. 18.

[131] Mark A. Gunzinger, *Sustaining America's Strategic Advantage in Long Range Strike*, Center for Strategic and Budgetary Assessments, 2010, p.21.

[132] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p.53.

restrictive timeframe) and providing 'public' proof of target neutralisation, and currently rely essentially on spatial or airborne observation assets. However, these assets cannot supply a continual stream of information from a particular point in the area covered[133]. The use of intrusive assets located very close to the target - which would resolve this issue - seems presently to be more a subject for research than actual operational development. However, recourse to solutions built around ground robots controlled from nearby aerial platforms is foreseeable in the medium term.

⇒ ***Signals intelligence*** (SIGINT) assets intercept radio transmissions or data flows transmitted from the target or its environment. More specifically, they may be useful in characterising air defence systems - search radar or even fire control radar systems - to monitor communications or detect activity in certain civilian systems, such as air traffic control.

These sensors are therefore capable of playing multiple roles in the context of prompt conventional strikes:

For missions to neutralise transmitting targets or those connected to a communication network (typically radar units or C2 centres), they can locate, detect and/or identify a target, creating the possibility to engage preparation of a CPGS mission.

More generally, SIGINT assets - and especially communication intercepts - provide target-related information that proves crucial in securing a maximum level of understanding regarding the intentions of the people or systems controlling the target. They can also be used in the subsequent battle damage assessment phase where the data can be processed fast enough to be used within time windows that are necessarily extremely tight.

⇒ ***Human intelligence*** (HUMINT) is considered to be a key factor in the ISR system, but it is also one of the most difficult assets to use effectively in the prompt strike context. The weaknesses of this type of intelligence are well known: lack of trained personnel, the difficulty of recruiting reliable sources and lengthy analysis and crosschecking times[134]. Nevertheless, where the use of human intelligence is limited to the action preparation phase (i.e. the most detailed level of knowledge about the target enabling identification of its vulnerabilities or simply confirming its presence in a given area, which may involve pinpointing it within its environment), it seems fair to assume that performance and time gains can be made in terms of intelligence gathering – including the collective orientation of sources[135] – and, possibly, from merging HUMINT data with that from other sensors. This final area of development seems crucial for the entire ISR function, since it involves enhancing the systems used to analyse and merge intelligence within a horizontally-orientated

[133] Defense Science Board, *Future Strategic Strike Forces*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, February 2004, p.3-6.

[134] Ibid, p.3-3. What is valuable for the USA is probably valuable for most countries, including France. The lack of human resources and mismatches between systems and requirements (variable in their degree) go some way to explaining the difficulties faced by the intelligence chain in processing the mass of information available.

[135] Department of Defense, *Persistent Intelligence, Surveillance, and Reconnaissance: Planning and Direction – Joint Integration Concept*, 29 March 2007, p.8.

system accessible to all the services involved, from analysts to planners and operational controllers[136].

As with observation and imaging assets, the process of analysing electronic intelligence (and quite clearly human intelligence) still relies to a very large degree on human involvement, despite the fact that some aspects of data processing are carried out automatically. In the long-term, the fact that increased volumes of information will be generated by the full range of sensors means that the role played by the services involved in the processing and analysis phase will become increasingly critical. As highlighted by a number of specialists, it is therefore urgent that this capability be reviewed in order to match requirements with the human resources actually available. As a result, it is important to underline the fact that the two intelligence chains are equally limited in terms of their ability to respond as a result of the fact that they are necessarily the focus of separate processing streams within the analytical loops and operated by different services. ***The result is that the exploitation of data is often sequential***: the various agencies (and armed forces) responsible for analysis process the gathered data separately – sometimes involving differences in the very nature of the platform used to carry the sensor – before forwarding the sifted data to decision-makers and, in some cases, to those responsible for implementing the operation.

It is also important to stress that the multiplicity of different parties involved in ISR, combined with the fact that they usually belong to two separate communities (intelligence and armed forces) – and sometimes to competing agencies or armed forces within these communities – is in itself a major obstacle to the introduction not only of a shared and efficient data processing structure, but also to complementary programmes of sensors and platforms[137].

But ultimately, the efficiency of all intelligence assets – in the context of their use to counter complex targets (and/or those in dense environments), sometimes within tight time constraints – relies on the existence of an overall architecture[138] capable of:

⇒ ***Enabling optimum orientation of available sources:*** Cooperation between the entities involved in data gathering, those responsible for data analysis and the operational units that will use the analysed data[139] is essential, especially where the time available for decision-making is short. However desirable for prompt strike effectiveness, the objective of taking full account of all operational requirements is not realistic given the current performance achieved by the intelligence cycle[140]. Nevertheless, it is possible to foresee the creation of a more

[136] Defense Science Board, *Future Strategic Strike Forces*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, February 2004, p.3-2.

[137] Government Accountability Office, *Intelligence, Surveillance, and Reconnaissance: DOD Can Better Assess and Integrate ISR Capabilities and Oversee Development of Future ISR Requirements*, March 2008, p.14.

[138] In the sense of an information system capable of managing sources and supplying the results of automated or human analyses.

[139] Including special forces deployed in the area, which is the case in some circumstances.

[140] Department of Defense, *Persistent Intelligence, Surveillance, and Reconnaissance: Planning and Direction – Joint Integration Concept*, 29 March 2007, p.6.

responsive loop based on the possibility of providing the armed forces with access to less well-analysed intelligence more quickly, where circumstances require it[141].

⇒ ***Facilitating/accelerating the processing (and distribution) of raw intelligence data.*** In this respect, the possibility of sensor-generated data being viewed in parallel and - possibly – cooperatively by several agencies and services seems one of the most promising ways for it, but other technology projects, including the automation of certain tasks, are planned by the US intelligence community: translation software, shape recognition systems, generation of annotated and referenced geographic dossiers, etc.

⇒ ***Ensuring the continuity of complementary intelligence gathering assets and enabling their location close to targets*** (at short notice, where necessary). The possibility of gathering target related data on a continuous basis proves to be an overall priority for the armed forces. The same applies to deep strike operations, particularly in the phases following the first attempt to neutralise a target. At this point, the focus is on obtaining real-time data on the execution of the mission, including the most accurate data possible regarding the post-attack status of the target. In all probability, the development of intrusive intelligence assets - those located impromptu/responsively in the immediate vicinity of the target - is also part of the possible future directions being explored by US services. Other areas of consideration could include systems with the ability to gather technical data: e.g. seismic, chemical or even acoustic[142]. The development of the Rapid Eye[143] airborne data gathering system for rapid deployment from the USA within just a few hours is one of the projects being conducted by the DARPA. The same agency is also currently working on the development of a pseudo satellite – effectively a UAV with an endurance window of several months – which could be reprogrammed rapidly to reflect intelligence, reconnaissance and/or surveillance requirements[144].

⇒ ***Achieving the usable merging of processed data to varying levels of accuracy to suit the full range of end uses.*** The ISR architecture therefore includes a series of central building blocks which must be structured around a command and control information system that is adaptable to the various levels of strike operations. This system must therefore merge information from multiple agencies and services to varying levels of detail, precision and/or technicality. However, the development of such a model comes up against not only technical difficulties, but also cultural and operational differences between the services involved, which seems likely to remain a major obstacle to the implementation of a cooperative orientation and exploitation capability.

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141 Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p.53.

142 Ibid, p.54.

143 *Statement by Dr Tony Tether, Director, DARPA*, Subcommittee on Terrorism, Unconventional Threats and Capabilities, House Armed Service Committee, 13 March 2008, p.12.

144 http://www.darpa.mil/Our_Work/TTO/Programs/Vulture/Vulture.aspx

These difficulties raise the need to ask ourselves questions regarding the medium-term reality of achieving the capability - regardless of technical progress – of gaining faster access to a body of actionable intelligence data about a given target so that it can be detected at a sufficiently early stage, its presence in a given area can be confirmed rapidly and it can be attacked using the assets available[145]. The process of putting together a comprehensive target dossier is a process that can take several days and require the availability of specific intelligence gathering resources. For example, observation satellites are not suited to tracking vehicles or people.

Within the time period under consideration, it will be important to reconcile the intelligence lead time with that required to take action, especially in respect of targets with a potentially short window of exposure/vulnerability located in dense and complex environments. The solutions cannot be purely technical[146], and the development of human intelligence capabilities (for example) assumes even greater value. However, the development of new autonomous, enduring/persistent and possibly intrusive sensors may provide a response to certain problems, as long as connectivity with the command and control network is reliable and efficient.

Command and control: challenges and directions for development

The command and control loop plays a key political and operational role in deep strike system operation. In the first instance, its purpose is to ensure that the chain of command operates under all circumstances, and is sufficiently responsive and secure to ensure that effectors receive authenticated orders rapidly. But it is also there to enable all the actors involved to receive actionable intelligence relevant to their function and decision-making level, preferably in sequences compatible with their levels of authority.

Consequently, the system must fulfil a series of operational and technical needs:

⇒ ***It must offer a level of bandwidth sufficient to ensure that the flow of data is not slowed or delayed***: this data can often be complex and therefore large in terms of data volume (images, videos, etc.). Over the period under consideration, the technical data that will pass through the armed forces communication system - including that vital for conducting deep strike operations - is likely to increase in volume and diversity[147]. In addition, the volume of data to be distributed will also be increased as a result of an almost continuous flow of information[148].

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[145] Austin Long, Dinshaw Mistry, Bruce M. Sugden, *Going Nowhere Fast: Assessing Concerns About Long-Range Conventional Ballistic Missiles*, International Security, Spring 2010.

[146] Despite the fact that they also rely on the complementarity of every component in the system, including effectors and their platforms.

[147] It is not hard to imagine that the volume of data from so-called exotic sensors (seismic, biometric, acoustic, chemical, etc.) and/or sensors located close to a target and supplying highly-topical data will grow considerably. See: *Statement of Dr. Tony Tether, Director Defense Advanced Research Projects Agency*, Subcommittee on Terrorism, Unconventional Threats and Capabilities, House Armed Services Committee, March 13, 2008, p.10.

[148] Général d'armée aérienne Palomeros, *'Quelles leçons pour les forces armées après les opérations en Libye ?'*, Club Athéna, 12 October 2011.

It will also enable the development of time critical strikes, for example, by distributing technical data that can be easily reused for direct input to effectors. Over and above the vital increases in performance delivered by greater bandwidth (including that required to supply data to operational units deployed in the theatre of operations), it seems essential to be able to introduce an intelligence cycle that is more responsive, including in terms of distributing data to the various operational levels.

⇒ ***It must be reliable under all circumstances and, more specifically, be capable of operating in complex environments*** (area denial actions and electronic countermeasures, including in the wake of electromagnetic pulses). The robustness and reliability of the system are all the more crucial since the decision to use the assets concerned will be taken at high level - especially where the targets concerned have a high political strategic value - with potentially serious political consequences. It must therefore be able to guarantee the authenticity of decision-making at every link in the chain up to the weapon system itself, just like the process currently used for nuclear weapons[149].

Even though the system may, in the medium - or long-term, be integrated into the operational command loop of military operations, it remains the case that certain operational requirements - particularly the option to reprogram or cancel strike whilst the weapon is in flight, where an intermediate and financially more affordable solution could be found in designing a down-only link designed to confirm the mission and, where such confirmation is not received, to abort the system in an unpopulated area - demand an extremely resilient communication system.

⇒ ***It must be capable of structured, rapid connection to all sensors, the principal operational commands*** (and participating services/agencies) and the political authorities[150]. It must therefore offer a fairly high degree of interoperability with other command and control assets, whilst protecting the classified data to be processed using the tools available in the command loop.

Similarly, the C2 system must undoubtedly be interoperable with the management system for deep strike actions, including those used for Special Forces missions. Without necessarily seeking total integration - which could run the risk of being counter-productive given the differences that exist between the various agencies, services and armed forces involved - it is undoubtedly desirable to be able to share data and supply the decision-making levels with a shared integrated overview of actions/operations in progress within a given area.

⇒ ***It must also enable (rapid) management of engagements, from action preparation to final battlefield damage assessment.*** In this respect, it would be reasonable to envisage a maximum overview of the system, which would include the C2 ISR platform described above as part of a Common Relevant Operational Picture or 'CROP' adapted to suit each level of contributor

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[149] Defense Science Board, *Time Critical Conventional Strikes from Strategic Standoff*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, March 2009, p.59.

[150] Defense Science Board, *Future Strategic Strike Forces*, Office of The Secretary of Defense Acquisition, Technology, and Logistics, US Department of Defense, February 2004, p.3-14.

(decision support for the political level, and management system for operations personnel and other versions adapted for other levels down to theatre level[151]). It could also enable modification of the current plan to incorporate intelligence and/or information emerging in real-time from the CS ISR platform or other connected command systems. Maximum responsiveness from the planning system is essential if we believe that the system must be capable of rapidly re-orientating or reprogramming an action on the basis of evaluating the outcomes of missions in progress and/or analysing data accessible to the intelligence cycles of other operations functions.

These considerations provide a glimpse of the technical and functional complexity inherent in creating an effective command and control system for a future deep strike function. In technical terms, the principal difficulty in developing the command system lies in creating a communication network capable of successfully addressing the key constraints of reliability, productivity/interoperability, high (and adaptive) bandwidth and resilience/robustness.

From the technical point of view, the USA seems to have made one of the greatest efforts of any Western country to prepare for deployment of a communication and command capability designed for compatibility with future armed forces missions. As part of modernising its armed forces communication network, the Pentagon is conducting several projects in parallel (from global satellite communications to battlefield assets) with the aim of incorporating the resulting systems into a network of networks called Transformational Communications Architecture or TCA. Progressive deployment of the component assets, many of which are based essentially on commercially-available systems, should provide a set of standard data exchange protocols with a forward development path to improve the interoperability of all military networks152.

The command and control architecture required - within the time period under consideration – to meet the deep strike requirements identified could therefore only be designed within the wider military C2 network development framework. In practical terms, this overarching system must respond effectively to the need to increase communications security and protection in light of the growth in digital risks. The communication and control network must also enable application of the selected level of decision-making, at the same time as delivering sufficient flexibility and responsiveness to accommodate the changes now underway in the intelligence world (real-time data flows, a growing requirement for analysis, etc.).

Although it is feasible to imagine that basic C2 capabilities are sufficient to manage the planning of 'deliberate' strikes[153] - those initiated following a long decision-making cycle of several days - it would seem difficult to retain such a model for time-critical

[151] See particularly: the Pentagon document on the ISR asset operation concept. Department of Defense, *Persistent Intelligence, Surveillance, and Reconnaissance: Planning and Direction*, 27 March 2007, p. 3. This document indicates that: *Requisite Command and Control (C2) is established among the theater and national ISR platforms, sensors, exploitation nodes and communications networks.*

[152] http://www.globalsecurity.org/space/systems/tca.htm

[153] Deliberate Strikes.

actions against targets exposed only for short periods or those whose vulnerability is confined to a given time window[154].

Lastly, future deep strike command and control networks will probably form part of a much wider military C2 to enable the combined conduct of complementary operations. Moreover, it seems equally possible that the latter should, as a minimum requirement, be interoperable/interconnectable with an associated architecture designed to permit the planning and conduct of joint operations at European or Transatlantic level[155].

[154] Returning to a previous example: the targeting of NRBC assets in the process of deployment or ballistic missiles prior to use are good illustrations of the underlying requirements of time-critical strikes.

[155] Undoubtedly a model similar to that planned for the missile defence C2, possibly including joint tasking functionality. Nevertheless, it would be wrong to underestimate the political difficulties attendant on such a development.

Conclusion

During the period under consideration, the deep strike function is likely to be characterised by requirements we can see emerging at the present time.

In the first instance, these capabilities will be used in complex situations in which enemy forces are intermingled with non-combatant population groups. Conflicts will tend increasingly to take place in very dense urban areas, which will be used by enemies to camouflage and protect their military assets. As a result, we are likely to see these trends lead to a significantly higher requirement for precision strikes being placed on future weapons systems, in terms both of standoff strikes and fire support missions. The quest for performance in this field is likely to drive a desire to improve effector capabilities. It will also have important consequences on the development of sensors and, in more general terms, will have a significant influence on intelligence processing and distribution requirements.

The development of anti-access and area-denial strategies and assets to limit the capability advantage of western armed forces is also likely to be a major influence on future conflicts. The distribution and standardisation of high-performance low- and medium-altitude[156] air defence systems could become one of the most influential factors governing the amount of use made of deep strike options. In all likelihood, this trend will lead to a more detailed examination of the specific requirements placed on these platforms and effectors in terms of penetration and survivability close to protected or covered areas. The likelihood that platform/vector combinations will be required to remain longer in contested areas in order to attack time-critical targets makes this all the more essential.

The ability to orientate strike assets rapidly to attempt the neutralisation of targets that are exposed only occasionally and/or those detected only at the last moment is another capability trend to emerge out of recent conflicts. Although the need for greater responsiveness throughout the intelligence and action chain is nothing new[157], the idea of using standoff strikes to deliver prompt attack of time-critical targets that may be located in areas not covered by force deployments is relatively recent. So it was the conventional prompt global strike principle advocated by the Bush administration post-2001 that provided the fertile ground from which this concept has sprung. In the US government concept – which has not been discounted by the current administration – the central issue is: *"the ability to hit a high-value political target anywhere on the earth in an hour or less"*[158]. Naturally, this definition has major consequences in terms of technical and technological requirements, not only for effectors, but also for intelligence architecture and command and control capabilities.

[156] S-300, S-400 and Tor-M1, for example (or Chinese copies of these systems).

[157] Especially for fire support missions, where the armed forces have always sought to reduce the time element of the OODA loop.

[158] Elaine Bunn, *Conventional Prompt Global Strike*, Asan Institute Plenum, June 13-15 2011, Seoul

As far as France (and possibly Europe) is concerned, it is not possible to imagine a future deep strike system capable of delivering such missions without this very requirement becoming the driving force behind weapons and enabling capabilities development. To be specific, it will undoubtedly involve capitalising on advances in technology to reduce response and target attack times, rather than developing (costly) solutions to respond to this requirement.

As a result, any examination of future deep strike capabilities must involve consideration of the role that high-performance effectors could play in terms of speed and penetration. So if the conversion of ballistic missiles seems worthy of being excluded at the outset for political and strategic reasons (essentially as a result of the strong link with the nuclear deterrent), consideration of using a supersonic cruise missile seems a practical proposition, especially given the fairly long lead time available before the use of this type of solution emerges on a global scale.

In any event, the need to continue existing efforts to modernise the intelligence loop and command and control assets should continue to be an important consideration. Rapid, global, secure access to information and technical data is vital to operation of the deep strike function. In this respect, it seems clear that the intelligence revolution will come about not only through the modernisation of technical assets (sensors, platforms and analytical systems), but also as a result of a major ‘leap forward’ in the quantity and quality of human resources.

Lastly, it should be emphasised that the future of the deep strike function could depend on two political and economic factors:

⇒ The feasibility of reducing the unit cost of effectors, which although not matching the level of cost involved in other precision weapons systems, could approach that level. American efforts on missiles like the *Tomahawk* demonstrate that a downward trend in costs is accompanied - in the US at least - by an upward trend in the number of systems of this type employed in the first phases of armed conflicts (especially for SEAD missions). Against a background of ongoing intensification and modernisation of their defence and anti-ship defence architectures by our potential adversaries, the need for a larger number of deep strike assets could prove more urgent.

⇒ The possibility of structuring a genuinely European capability around a joint definition of strategic and operational requirements should be explored. In reality, this is undoubtedly one of the most structurally important aspects of greater cooperation between the principal actors on the issues of effectors and C4ISR architecture: a Franco-British convergence would appear to be achievable in light of the lessons that will be drawn from recent operations and those to come, but technical/operational options with other leading European partners (Scandinavia, Germany, Italy and the Netherlands) deserve to be discussed and explored.

⇒ However, such consultation can only come about if it is preceded by a joint effort to reconcile the countries involved to a united view on the general conditions governing the use of this type of capability. In practical terms, the current divergences between a strategic model - one intended to mount occasional attacks on high-value political targets and controlled exclusively and directly by the political authorities - and a capability designed to fulfil general tactical missions, as well as occasional strategic operations, and controlled by the armed forces, are such that they will delay or even prevent true convergence between the requirements of European nation states beyond simply acknowledging the political benefits of possessing weapons systems capable of reaching targets beyond the reach of our piloted assets.