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NATO STRATEGIC AIRLIFT CAPABILITIES A COMPARATIVE ANALYSIS

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Abstract

The Strategic airlift has been a long-standing critical shortfall for the NATO Alliance. At the Riga summit, NATO Heads of State and Governments noted the need for *"forces that are fully deployable, sustainable and interoperable and the means to deploy them."* They also endorsed several initiatives to increase strategic airlift, including the SAC, the Strategic Airlift Interim Solution (SALIS), and offers to coordinate support structures for A-400M strategic airlift, which seven allies are planning to acquire beginning in 2010. All these initiatives are now encompassed by a new concept developed at Chicago Summit in May 2012 – *Smart Defence*.

Keywords*: NATO, strategic airlift, capabilities, project*

1. Introduction

The Strategic airlift has been a long-standing critical shortfall for the NATO Alliance. At the Riga summit, NATO Heads of State and Governments noted the need for *"forces that are fully deployable, sustainable and interoperable and the means to deploy them."* They also endorsed several initiatives to increase strategic airlift, including the SAC, the Strategic Airlift Interim Solution (SALIS), and offers to coordinate support structures for A-400M strategic airlift, which seven allies are planning to acquire beginning in 2010. All these initiatives are now encompassed by a new concept developed at Chicago Summit in May 2012 – *Smart Defence*.

The term Smart Defence was coined by the current NATO Secretary General, and he has invested a lot of personnel and political capital to developing it. NATO Secretary General Anders Fogh Rasmussen publicly started to use the term "Smart Defence" at the beginning of 2011, giving several speeches in which he endorsed the development of multinational cooperation, economic planning and regional approaches to build improved Alliance capabilities. In an article in the July/August 2011 edition of *Foreign Affairs*, wrote:

"Smart Defence is about building security for less money by working together and being more flexible. That requires identifying those areas in which NATO allies need to keep investing. (...) Smart Defence also means encouraging multinational cooperation. Nations should work in small clusters to combine their resources and build capabilities that can benefit the alliance as a whole. Here NATO can act as a matchmaker, bringing nations together to identify what they can do jointly at a lower cost, more efficiently and with less risk."

Multinational projects are a concrete illustration of the Smart Defence initiative, a new way of cooperation among NATO nations. As defence budgets are under pressure, Smart Defence represents a renewed emphasis on multinational cooperation in order to provide cost-effective security in a period of economic austerity.

NATO STRATEGIC AIRLIFT CAPABILITIES
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"The financial crisis is one more reason why we should strive for greater cooperation between the European Union and NATO. The benefit is clear. If we work together, then both our institutions can emerge stronger from these times of economic difficulty," explained NATO Secretary General Anders Fogh Rasmussen, addressing the chairmen of parliamentary committees on foreign affairs from across the EU in April 2012.

This paper is an attempt to represent a succesfull examples of longlasting cooperation between nations in order to achieve a common goal: *strategic airlift capabilities*, and also a compartive analysis of the programmes initiated to support these capabilies.

2. Strategic Airlift Capabilities

2.1 Strategic Airlift Interim Solution (SALIS)

2.1.1 Programme background

During their annual spring meeting in Brussels in June 2003, NATO Ministers of Defence signed letter of intent on strategic air- and sealift, at that time eleven nations signed the letter of intent on airlift. One year later on 28 June 2004, during Istanbul Summit, Defence Ministers of 15 countries: Canada, the Czech Republic, Denmark, France, Germany, Hungary, Luxembourg, the Netherlands, Norway, Poland, Portugal, Slovak, Slovenia, Spain and Turkey, signed a memorandum of understanding to achieve an operational airlift capacity for outsize cargo by 2005, using up to six Antonov An-124-100 transport aircraft.

In January 2006, the 15 countries signed a contract with Ruslan SALIS GmbH, a subsidiary of the Russian company Volga Dnepr, based in Leipzig.

In March 2006, the 15 original signatories were joined by Sweden at a special ceremony in Leipzig to mark the entry into force of the multinational contract. The contract's initial duration was for three years but this has been extended until the end of 2014 with option to be extend until December 2017.

The SALIS contract provides two Antonov An-124-100 aircraft on part-time charter, two more on six days' notice and another two on nine days' notice. The countries have committed to using the aircraft for a minimum of 1859 flying hours per year and for 2000 flying hours per year for 2013 and for a minimum of 2450 flying hours for 2014. Additional aircraft types i.e. IL-76 and An-225 are included in contract but it use is subject to availability.

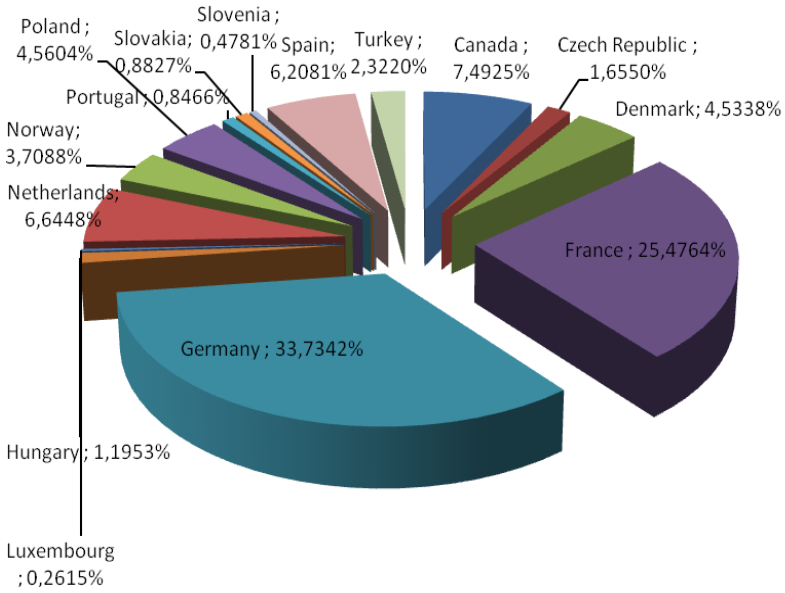

Fig.1 SALIS Programme participants (based on 2012 MoU)

Volga-Dnepr and Ukraine's ADB provide the SALIS aircraft and also provide AN-24-100 aircraft to support Afghanistan mission, with weekly sorties from Europe to Afghanistan and back, under contractual arrangement with NATO Support Agency (NSPA).

The capabilities of SALIS will play a big role in on-going Afghanistan re-deployment.

Strategic airlift co-ordination is carried out by the SALIS Co-ordination Cell collocated with but not part of the Movement Coordination Centre Europe (MCCE) in Eindhoven, the Netherlands.

Following Russia's annexation of Crimea in March 2014, NATO foreign ministers announced on 1 April a decision "to suspend all practical civilian and military cooperation between NATO and Russia." A North Atlantic Council meeting at the level of foreign ministers on 24-25 June 2014 decided to maintain the suspension, as did the NATO Summit meeting in Wales 4-5 September. One area thus far unaffected by this decision is cooperation with Russian commercial air services providing heavy airlift support for NATO- and EU-led military and humanitarian relief operations as well as for members' national military requirements.

The decision to rely on charters of Russian and Ukrainian transport aircraft to satisfy the heavy airlift requirements of NATO and EU military forces was determined primarily by the significant advantages offered by the An-124 in comparison with other large cargo aircraft. The An-124 has nearly twice the payload capacity and greater range than a Boeing C-17, and it is more cost effective to operate. It can load and unload cargo from both ends and its ability to "kneel" for front-end loading and its built-in cranes and winches make rapid turnarounds possible even at underdeveloped airfields.

The contract for lease of the An-124-100 Ruslan was recently extended until the end of 2016. Under the terms of the contract, two An-124-100 Ruslan aircraft are permanently based in Germany and four are provided to the customer on demand. The partners and the NATO Maintenance and Supply Agency (NAMSA) signed a three-year contract (with the option of extension) worth EUR 600 million for transportation of cargo on behalf of

NATO and the European Union in late 2005. The contract was extended by two years in late 2008, in 2010, and in 2012.

2.1.2 An-124-100 Technical specifications

The AN-124-100 commercial aircraft has been developed on the basis of the AN-124 "Ruslan" heavy military transport aircraft. It is the biggest serial heavy lifter in the world. It is intended for the transportation of heavy and oversized cargo and various special-purpose vehicles. In 1992, ANTONOV obtained the Type Certificate for the AN-124-100. The aircraft meets the noise level requirements of Part III, Appendix 16, of the ICAO regulations, requirements relating to emissions of aviation engines, accuracy of piloting, flights under conditions of short vertical separation spacing, etc.

The AN-124-100 has a double-deck fuselage layout. On the upper deck, there is the cockpit and relief crew compartment and the cargo attendants' cabin. The lower deck is a pressurized cargo compartment. The construction and dimensions of the forward and rear cargo doors, closed with ramps, ensure quick and easy loading/unloading operations. The onboard ceiling mounted cranes allow loading/unloading without ground equipment. The multi-wheel landing gear with rough-field capability, two APUs and mechanized loading enable independent operation of the aircraft from poorly equipped airfields. Simplicity, reliability and safety of the aircraft operation are ensured by the redundancy and computerization of its systems.

Primary Function: Transport aircraft
Prime Contractor:
Power Plant: Four Ivchenko Progress D-18T Turbofans
Thrust: 229.5 kN (51600 lbf), each engine
Wingspan: 240 feet (73.3 meters)
Length: 226 feet (68.96 meters)
Height: 68 feet 2 inch (20.78 meters)
Cargo Compartment: length, 36,5 meters; width, 6,4 meters; height, 4,4 meters
Speed: 865 km/h
Service Ceiling: 35,000 feet at cruising speed (12,000 meters)
Range: 4,500 km (with maximum payload)
Crew: Six
Payload: 150,000 Kg (330,695 lb.)
Maximum Takeoff Weight: 405,000 Kg (892,875 lb.)
Unit Cost: $80 million
Date Deployed: June 1986
Inventory: 56

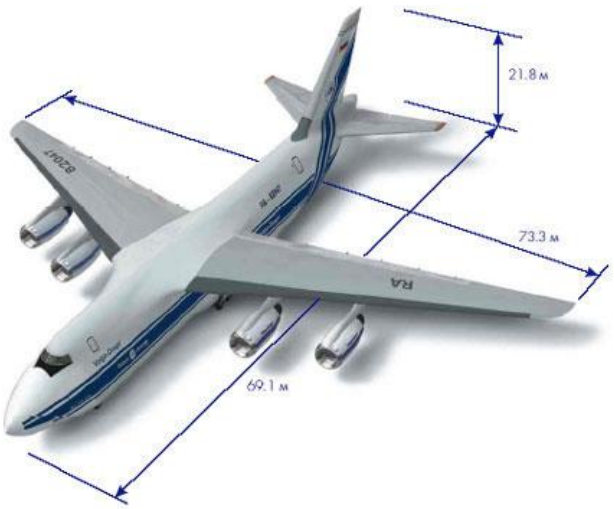

Fig.2 An-124-100 main dimensions

2.2 Strategic Airlift Capabilities (SAC)

2.2.1 Programme background

The Strategic Airlift Capabilities (SAC) concept started at NATO HQ in mid-2006. NATO officials and national representatives envisaged a partnered solution that would

satisfy a need for strategic airlift for members' states without the economic resources to field a permanent capability. Originally this idea was called the NATO Strategic Airlift Capabilities (NSAC). In October 2006 the first non-NATO nation joined the initiative and the concept changed its name to SAC and moved outside the Alliance.

On 23 September 2008 ten NATO members (Bulgaria, Estonia, Hungary, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia and the United States) and two NATO Partnership for Peace (PfP) nations (Finland and Sweden) have signed the Memorandum of Understanding and Strategic Airlift Capability programme was borne.

After its establishment, SAC proceeded quickly from an idea into an operational airlift initiative.

On 14 July 2009, Strategic Airlift Capability received its first C-17 aircraft, bearing the registration SAC 01. The remaining two aircraft, SAC 02 and 03, were delivered in the following months and operations with the Heavy Airlift Wing started immediately thereafter at Pápa Air Base.

In November 2012 the Heavy Airlift Wing achieved Full Operational Capability (FOC). The unit was then considered fully capable of missions containing air refueling, single ship airdrop, assault landings, all-weather operations day or night into low-to-medium-threat environments, limited aeromedical evacuation operations and utilizing C-17 air-land and air-drop mission capabilities.

Since 2009 the Strategic Airlift Capability has supported a variety of operations at its 12 member nations' requests including the International Security Assistance Force (ISAF, 2009 – 2014) and the Resolute Support Mission (RSM, 2015 –) in Afghanistan, NATO operations in Libya (2011), UN Multidimensional Integrated Stabilization Mission in Mali (MINUSMA, 2013–), the European Union military operation EUFOR RCA (2014 – 15) and the UN mission MINUSCA in the Republic of Central Africa (2015 –).

Strategic Airlift Capability has also participated in the logistics support provided to the investigation of the 2014 Malaysia Airlines MH17 crash in Ukraine.

In addition to the above operations, significant humanitarian operations supported include earthquake relief in Haiti (2010) and flood relief in Pakistan (2010).

Although the Strategic Airlift Capability relies on certain NATO support structures, it transcends the military and political alliances like the NATO and the European Union. The governing bodies of the program are the Strategic Airlift Capability Steering Board and the NATO Airlift Management Programme Board that consists of representatives of the member nations.

The SAC Steering Board exercises overall responsibility for the guidance, execution and oversight of the Strategic Airlift Capability in accordance with the SAC Memorandum of Understanding. It formulates SAC requirements and communicates them to the NAM Programme Board for execution.

The Strategic Airlift Capability has a lifespan of a minimum of 30 years and its member nations have committed to constant development of the program and its capabilities.

According to the Strategic Airlift Capability Memorandum of Understanding, SAC nations have access to 3,165 annual C-17 flight hours produced by the Heavy Airlift Wing. The hours are divided among nations according to a pre-agreed share.

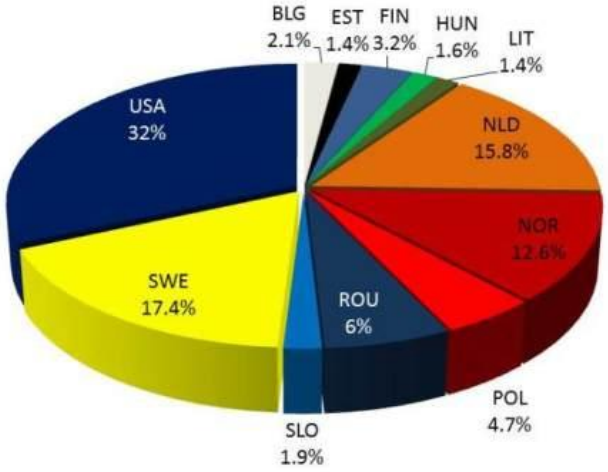

Fig.3 SAC participants based on 2008 MoU

The Strategic Airlift Capability is widely seen as a groundbreaking initiative in the field of smart defense and pooling and sharing of defense capabilities.

SAC C-17s are operated by the Heavy Airlift Wing (HAW), the operational arm of the program. The wing is manned with personnel sent by the 12 SAC member nations making it the first operational multinational military airlift unit in the world.

The aircraft and supporting equipment operated by the Heavy Airlift Wing are owned by the NATO Airlift Management Programme on behalf of the SAC Nations.

The NAM Programme is the legal entity of SAC and an integral part of the NATO Support and Procurement Organization, and consists of a Programme Board and a Programme Office. The NAM Programme Office is executing the ownership roles of the NAM Programme and related responsibilities for the assigned aircraft and other assets, and performs configuration / sustainment management of the C-17 weapon system. In addition, it contracts on a competitive basis logistics support identified by the Commander of the HAW, administers approved operations budgets for the HAW and provides legal, procurement and information technology services for the wing.

The symbotic relationship between NAM and SAC can simply be described as one between a customer (SAC) and a provider (NAM Programme).

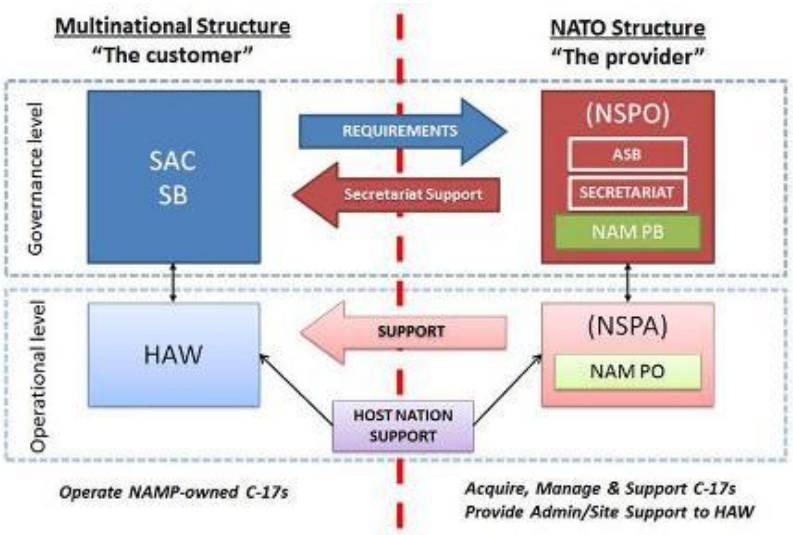

Fig.4 Relationship diagram between NAMP and SAC

Besides these two main product lines, support is provided in the field of Information Systems, Legal Affairs and Organizational Development.

Strategic Airlift Capability relies on a partnership also in the technical support of the C-17 aircraft. The manufacturer of the C-17, the Boeing Company, is contracted through the Foreign Military Sales (FMS) program of the United States Government by the NAM Programme Office. Boeing is responsible for the maintenance of SAC aircraft and support equipment, engineering and technical support and the management and supply of C-17 spare parts. For this purpose Boeing has based a Field Services Integrated Product Team at the Pápa Air Base.

As of March 2015, the Strategic Airlift Capability C-17 fleet has achieved over 15,000 flying hours, flown over 1,100 missions, delivered over 105 million pounds (over 47,000 tons) of cargo and carried over 60,000 passengers.

2.2.2 C-17 Globemaster III Technical specifications

The C-17 Globemaster III is the newest, most flexible cargo aircraft to enter the airlift force. The C-17 is capable of rapid strategic delivery of troops and all types of cargo to main operating bases or directly to forward bases in the deployment area. The aircraft can perform tactical airlift and airdrop missions and can transport litters and ambulatory patients during aeromedical evacuations when required

The ultimate measure of airlift effectiveness is the ability to rapidly project and sustain an effective combat force close to a potential battle area. Threats to U.S. interests have changed in recent years, and the size and weight of U.S.-mechanized firepower and equipment have grown in response to improved capabilities of potential adversaries. This trend has significantly increased air mobility requirements, particularly in the area of large or heavy outsize cargo. As a result, newer and more flexible airlift aircraft are needed to meet potential armed contingencies, peacekeeping or humanitarian missions worldwide. The C-17 is capable of meeting today's demanding airlift missions.

The aircraft is powered by four, fully reversible, Federal Aviation Administration-certified F117-PW-100 engines (the military designation for the commercial Pratt & Whitney PW2040), currently used on the Boeing 757. Each engine is rated at 40,440 pounds of thrust. The thrust reversers direct the flow of air upward and forward to avoid ingestion of dust and debris. Maximum use has been made of commercial off-the-shelf equipment, including Air Force-standardized avionics.

The aircraft is operated by a crew of three (pilot, co-pilot and loadmaster), reducing manpower requirements, risk exposure and long-term operating costs. Cargo is loaded onto the C-17 through a large aft door that accommodates military vehicles and palletized cargo. The C-17 can carry virtually all of the Army's air-transportable equipment.

Maximum payload capacity of the C-17 is 170,900 pounds (77,519 kilograms), and its maximum gross takeoff weight is 585,000 pounds (265,352 kilograms). With a payload of 169,000 pounds (76,657 kilograms) and an initial cruise altitude of 28,000 feet (8,534 meters), the C-17 has an unrefueled range of approximately 2,400 nautical miles. Its cruise speed is approximately 450 knots (.74 Mach). The C-17 is designed to airdrop 102 paratroopers and equipment.

The design of the aircraft allows it to operate through small, austere airfields. The C-17 can take off and land on runways as short as 3,500 feet (1,064 meters) and only 90 feet wide (27.4 meters). Even on such narrow runways, the C-17 can turn around using a three-point star turn and its backing capability.

Primary Function: Cargo and troop transport
Prime Contractor: Boeing Company
Power Plant: Four Pratt & Whitney F117-PW-100 turbofan engines
Thrust: 40,440 pounds, each engine
Wingspan: 169 feet 10 inches (to winglet tips) (51.75 meters)
Length: 174 feet (53 meters)
Height: 55 feet 1 inch (16.79 meters)
Cargo Compartment: length, 88 feet (26.82 meters); width, 18 feet (5.48 meters); height, 12 feet 4 inches (3.76 meters)
Speed: 450 knots at 28,000 feet (8,534 meters) (Mach .74)
Service Ceiling: 45,000 feet at cruising speed (13,716 meters)
Range: Global with in-flight refueling
Crew: Three (two pilots and one loadmaster)

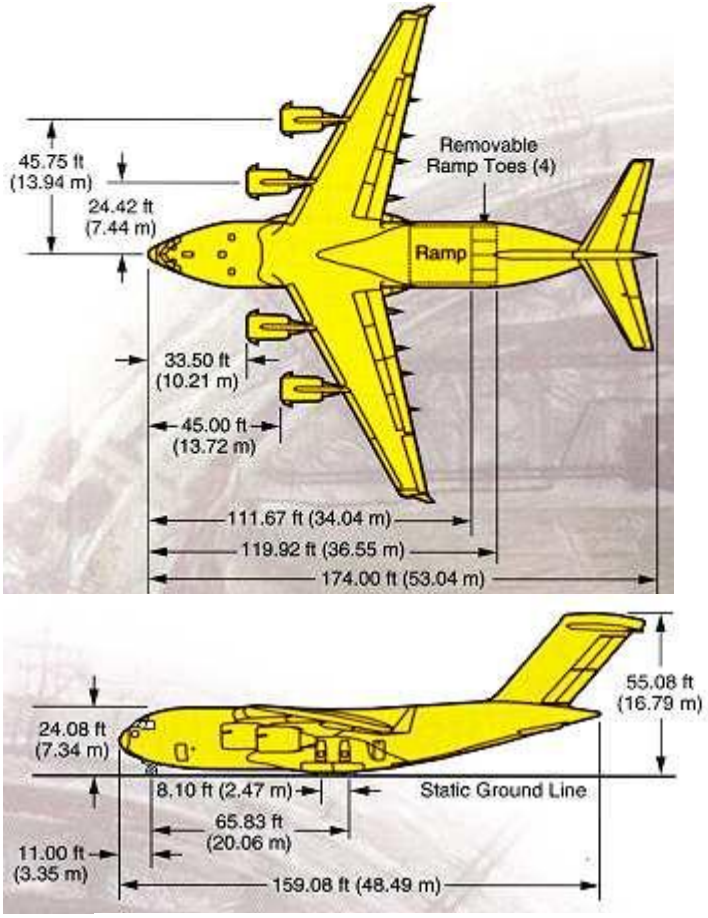

Fig.3 C-17 main dimensions

Aeromedical Evacuation Crew: A basic crew of five (two flight nurses and three medical technicians) is added for aeromedical evacuation missions.
Medical crew may be altered as required by the needs of patients
Maximum Peacetime Takeoff Weight: 585,000 pounds (265,352 kilograms)
Load: 102 troops/paratroops; 36 litter and 54 ambulatory patients and attendants; 170,900 pounds (77,519 kilograms) of cargo (18 pallet positions)
Unit Cost: $202.3 million (fiscal 1998 constant dollars)
Inventory: Active duty, 187; Air National Guard, 12; Air Force Reserve, 14; SAC, 3; UK, 6; Canada, 4; Australia, 4; Qatar, 2; India, 6 (4 more on order)

2.3 A-400M Programme

2.3.1 Programme background

After years of waiting, on May 2003 eight Europeans countries (France, Germany, Spain, Italy, the UK, Turkey, Belgium, and Luxembourg) have signed one's of the most ambitious contract to fulfil their need of tactical and strategic airlift and also to replace their aged fleet of C-130 and C-160 Transall. The contract was signed between the Airbus and the new created European procurement agency OCCAR for 212 aircraft. After Italy withdrew its order the number of aircraft ordered was reduced to 180 with deliverers to start in 2009 and continues until 2020.

Airbus Military SL of Madrid, a subsidiary of Airbus Industry, is responsible for management of the A400M programme. Other companies with a share in the programme are: BAE Systems (UK), EADS (Germany, France and Spain), Flabel

(Belgium) and Tusas Aerospace Industries (Turkey). Final assembly took place in Seville, Spain.

In January 2009, EADS postponed the first deliveries of the A400M until 2012 and proposed to develop a new approach for the A400M to discover new ways to advance the programme.

2009 continued to be a troubled year for the A400M as estimates on the cost overrun of the project were released with predictions of up to €11.2bn over budget.

In November 2010 Belgium, Britain, France, Germany, Luxembourg, Spain and Turkey agreed to lend Aribus €1.5bn and proceed with the programme, however Germany and the UK reduced the number of aircraft ordered to 53 and 22 respectively, taking the total down to 170. With the contract signed by Malaysia in 2005, for purchase of four A400M, the total firm orders for the A400M stand at 174 aircraft.

First deliveries will be to the French Air Force and will take place in the second quarter of 2013. Deliveries are expected to conclude in 2025.

Date	**Country**	**Order**	**Entry into service date(first delivery)**	**Notes**
27 May 2003	Germany	53	Dec.2014	Order reduced from 60 to 53, and will try to resell 13
	France	50	August 2013	
	Spain	27	Expected 2016	Requirement reduced to 14 aircraft and will try to resell 13
	United Kingdom	22	Nov. 2014	Order reduced from 25 to „at least 22”
	Turkey	10	April 2014	A400M deliveries to be completed by 2018.
	Belgium	7	Expected 2018-2020	
	Luxembourg	1	Expected 2019	
8 Dec 2005	Malaysia	4	March 2015	
TOTAL		**174**		

Table 1 – A400M Programme participants

2.3.2 A400M Technical specifications

The A400M is the most versatile airlifter currently available responding to the most varied needs of world Air Forces and other organizations in the 21st century.

It can perform three very different types of missions:

- tactical missions directly to the point of need
- long range strategic/logistic missions
- air to air refueling “tanker”

Powered by four unique counter-rotating Europrop International (EPI) TP400 turboprop powerplants, the A400M offers a wide flight envelope in terms of both speed and altitude. It is the ideal airlifter to fulfill the most varied requirements of any nation around the globe in terms of military, humanitarian and any other “civic” mission for the benefit of society.

The A400M has been rigorously designed to meet the equipment transport needs of modern armed forces. The A400M can perform missions which previously required two - or more - different types of aircraft, and which even then provided an imperfect solution. Its fuselage external width of 5.64 meters / 18 ft 6 in is equal to that of the A330/A340 wide-body. Its cargo hold has an inside usable width of four meters / 13ft, height of up to four meters / 13ft, and usable length of 17.71 meters / 58 ft.

With a maximum payload of up to 37 tones (81 600 lb) and a volume of 340 m3 (12 000 ft3), the A400M can carry numerous pieces of outsize cargo including, vehicles and helicopters that are too large or too heavy for previous generation tactical airlifters, for example, an NH90 or a CH-47 Chinook helicopter, or two heavy armored vehicles for military purposes. It can also carry a heavy logistic truck, or a rescue boat, or large lifting devices, such as excavators or mobile cranes needed to assist in disaster relief.

The A400M has been specifically designed for low detestability, low vulnerability and high survivability. Its high maneuverability, its enhanced low level flight capability, its steep descent and climb performance, as well as its short landing and take-off performance, its damage tolerant flight controls, its armored cockpit and bullet-resistant windscreens, the use of inerting gas in the fuel tanks as well as the segregated routing of hydraulics and wiring give it excellent self-protection and survivability. With its minimal infra-red signature EPI TP 400 turboprops, highly responsive fly-by-wire flight controls, four independent control computers, comprehensive defensive aids, and damage tolerant controls, the A400M is hard to find, hard to hit and hard to kill.

Primary Function: Military transport aircraft
Prime Contractor: Airbus Company
Power Plant: Four Europrop TP400-D6 turboprop
Thrust: 8,250kW (11,060 hp) each engine
Wingspan: 42,4 meters
Length: 45,1 meters
Height: 14,7 meters
Cargo Compartment: length, 17,71 meters on flat floor, 5,40 meters on ramp; width, 4 meters; height, 3,85 meters)
Load: 116 troops/paratroops (with the addition of two fully removable rows of centerline seats; 66 stretchers for medical evacuation; 81,571 pounds (37,000 kilograms) of cargo (9 pallet positions)
Speed: max. cruise speed 780 km/h
Service Ceiling: 11,278 meters max.
Unit Cost: about £140 million; or about $192 million.
Inventory: Active duty, 11; France, 6; Germany, 1; United Kingdom, 1; Turkey, 2; Malaysia, 1;

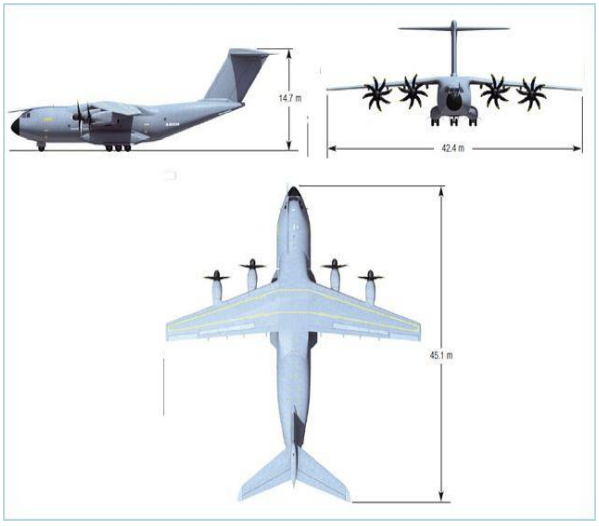

Fig.6 A400M main dimensions

3.Comparative Analysis

3.1. Economical Consideration

NATO STRATEGIC AIRLIFT CAPABILITIES
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Demand for military airlift capability has risen sharply over the past years, and European armed forces are resorting to a range of aircraft to fill the gap. This study presents three different solutions taken by EU nations in order to fulfil their need of strategic airlift. Each solution represents a different approach and the results are quantified different.

The SALIS Programme is similar with a lease contract for which fifteen EU nations have contracted an airlift capabilities with intend to close the existing gap for strategic airlift for outsized cargo in the most cost efficient manner. Their purpose was mainly driven by rapid deployment of equipment in support of NATO and EU operations. Through the contract, the contractor will provide assured access for up to six An-124-100 aircraft no later than six days after notifications. In such case these six aircraft will be available for up to twenty consecutive days and able to fly a minimum of 800 flying hours.

Following Russia's annexation of Crimea in March 2014, NATO foreign ministers announced on 1 April a decision "to suspend all practical civilian and military cooperation between NATO and Russia." A North Atlantic Council meeting at the level of foreign ministers on 24-25 June decided to maintain the suspension, as did the NATO Summit meeting in Wales 4-5 September. One area thus far unaffected by this decision is cooperation with Russian commercial air services providing heavy airlift support for NATO- and EU-led military and humanitarian relief operations as well as for members' national military requirements.

SALIS Programme proved the participants expectation and seems to be the most cost effective interim solution to satisfy the needs of strategic airlift, the only issue arise is that the contracted capabilities do not permit operational or tactical airlift to be contracted.

The national cost share for SALIS Programme covers both administration and operating costs. Participants of the SALIS agreement each have an annual allocation of hours and each nation prepays a portion of those total allocated hours. For FY 2005/06 – 2009/10, the cost of programme was $3,835,184.

The Strategic Airlift Capability (SAC) was a new concept for NATO when initiated a few years ago. The successful establishment of SAC can be largely explained by its concept, consisting of pooling resources in order to acquire maximum airlift capability for many nations, in a restrictive budgetary environment. The sound concept on which programme has been founded matches perfectly the new NATO strategy, investing in more flexible and mobile armed forces, while capitalizing on collaborative defense projects and avoiding capabilities duplication.

Ten NATO member countries (Bulgaria, Estonia, Hungary, Lithuania, the Netherlands, Norway, Poland, Romania, Slovenia, and the United States) and two Partnership for Peace nations (Finland and Sweden) established SAC by signing the SAC Memorandum of Understanding (MoU).

By comparison, the countries that signed the SAC MoU have committed themselves to SAC for 30 years and purchased the aircraft together; they did not just contract flight hours from a commercial enterprise. Based on their initial contribution to the programme the SAC participants are entitled to a corresponding percentage of the available flight hours and therefore provides assured access to strategic airlift capability. Each participating nation owns a share of the available flight hours that can be used for missions without the prerequisite to consult with the other SAC Participants.

For SAC Programme participants agree that the total cost of the programme will be under the Cost Ceiling of $5,944.1 million in the Base Year (BY) 2007, including

acquisitions and operations costs. Each participant will have both an Acquisition Segment and an Operations Segment within SAC Program. Within operational Segment a distinction exists between the fixed and variable costs. Fixed costs are those directly related to the SAC Program, and are not influenced in the short term by actual versus planned Flight Hours. Variable costs are directly related to a mission performed and therefore will be paid by Participants using the actual Flight Hours. Important to be noted is the fact that within Acquisition Segment, the U.S. share will be one C-17 aircraft provided as a Non-financial contribution, the remaining two C-17 aircraft are supported by other participants based on their cost shares.

The A400M programme is a combination of political, industrial and economic reality. The A400M programme will support 10,000 European jobs, a large diverse and multinational supply chain, billions in tax revenues and re-establishes European skills in large military aircraft/turboprop design thus countering current US and Russian domination in the sector. Many people see industrial issues as either irrelevant to defence needs, but the others see the A400M as a Europe work programme and this make perfect sense from a geo-industrial perspective.

Airbus stated as of 2003 that the A400M unit cost was around $80 million and the total cost of program was officially valued at $17.5 billion, but the actual cost were more likely to exceed $22 billion, and the cost per A400M aircraft was more likely to be $120 - $130 million. One of the bigger advantages of the A400M is that it was designed to meet the requirements of eight European Air Forces, maintenance operations in a joint industrial consortium which means an important step forward in standardization of Europe's fleet of tactical transport. Moreover, this will provide for an improved interoperability level and the option of consolidating major

3.2. Tactical and Strategic Capabilities

3.2.1 Cargo

Aircraft	Cargo compartment			MTOW	Max. Payload	Number of pallets
	Length	Width	Height			
	[m]	[m]	[m]	[Kg]	[Kg]	
C-17	26	5.48	3.76/4.11	265.300	76.644	18
A400M	17.71	4	3.85/4	141.000	37.000	9
An-124-100	36	6.4	4.4	405.000	150.000	

Table 2 – Tactical capabilities

With a maximum payload of up to 150 tones and a volume of 1050 m^3, the An-124-100 has a transportation capability two times higher than C-17 Globemaster III and four times higher than A400M. Both C-17 Glomemaster III and A400M were designed for military purpose and are suitable with all of the Army's air transportable equipment.

3.2.2 Personnel

Aircraft	Number of pax Standard	Number of pax. Config.	Notes
C-17	102	188	
A400M	58	116	
An-124-100	24	-	No passenger on cargo area due to pressurization.

Table 3 – Passengers capabilities

C-17 Globemaster III is fitted with 27 seats along each side of the cargo bay, and 48 more seats can be installed in the centre of the cargo bay, providing seats for 102 fully-equipped troops. C-17 can also be configured for passenger transportation only and additional seats pallets can be loaded providing in total 188 seats available.

The A400M can also carry 116 personnel, or paratroops. Because of the width of the A400M's fuselage, they can be seated in four rows, all along the two sides of the fuselage, and back to back along the centre-line, with enough space in between the facing rows.

Up to 24 passengers can seat in passenger compartment up-stair on An-124-100 aircraft. The cargo compartment is not pressurized therefore no troops or staff are transported there.

3.3 Strategic Performance

Aircraft	Maximum Range / payload	Maximum Cruise Altitude	Cruise Speed Normal	Cruise Speed	Take-off Field Length	Rate of Climb
	Km	[Ft] (m)	[Knots] (km/h)	[Knots] (km/h)	[Ft] (m)	[Ft/min]
C-17	5200	45000 (13716)	450 (833)	450 (833)	7600 (2300)	1500 (457)
A400M	4535	40000 (12192)	300 (555)	300 (555)		
An-124-100	4500	35000 (10668)	459 (850)	432 (800)	9186 (2799)	3300 (1000)

Table 4 – Strategic performance

The A400M provides a new standard of performance for tactical airlifters, and offers global reach at high speed, whilst still retaining the capability of landing at austere airfields. With a typical payload of 20 tones (44 000 lb) allowing to airlift a Cat II MRAP, 20 troops and two pallets over an operating range of 3450 nm (6400 km), the A400M provides a true strategic range capability.

With its maximum payload of 37 tones (81 600 lb) allowing to airlift a heavy mobile crane, four personnel and three military pallets, the A400M has an operating range of 1780 nm (3300 km).

Flying faster and higher, can respond more rapidly to crises, because greater distances can be flown in a one crew duty day. The A400M is hence much more efficient than its predecessors. Also, as it can fly higher, it can cruise above poor

weather and turbulence of found at medium altitudes, resulting in less fatigue for the crews, and passengers or troops alike.

Maximum payload capacity of the C-17 is 170,900 pounds, and its maximum gross takeoff weight is 585,000 pounds. With a payload of 130,000 pounds and an initial cruise altitude of 28,000 feet, the C-17 has an unrefueled range of approximately 5,200 nautical miles. Its cruise speed is approximately 450 knots (.77 Mach).

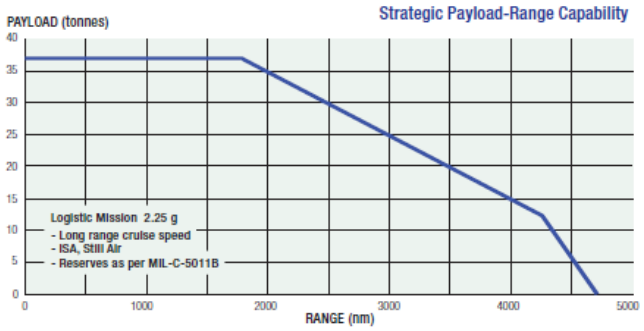

Fig.7 A400M Maximum payload capacity

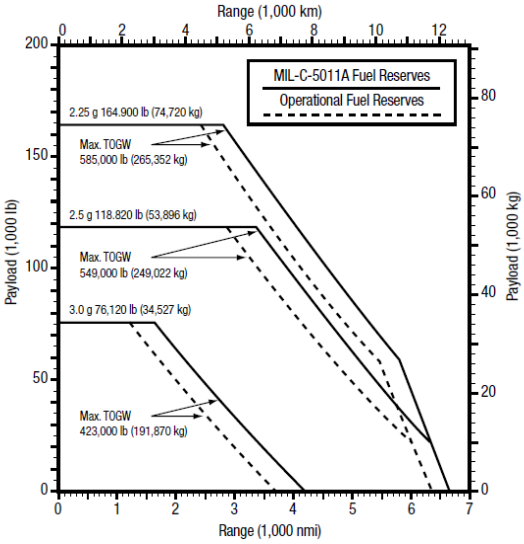

Fig.8 C-17 Maximum payload capacity

3.4 Tactical Performance

3.4.1 Short Unpaved Airstrip Performance

Thanks to its unique short landing characteristics, the A400M is the only large airlifter that can fly equipment and personnel directly to the site of action, where these materials are urgently needed. In addition to its Europrop EPI TP400 Turboprops, which are less sensitive to ingestions than jet engines, the A400M is fitted with a twelve-wheel main landing gear and an efficient absorption of shock-loads into the airframe structure for operations from stone, gravel or sand strips, and is designed to minimize risk of foreign object damage.
The A400M is therefore able to land on, and take-off from, any short, soft and rough unprepared CBR 6 airstrip, no longer than 750 m / 2,500 ft, while delivering up to 25 tones / 55,000 lb of payload, and with enough fuel on board for a 930 km / 500 nm return trip. In addition to offering optimized support to deployed military operating bases, these characteristics also allow it to ensure that swift humanitarian aid can be deployed direct to a disaster region.

The C-17 can operate on small, austere airfields with runways as short as 3,000 feet (914m) and as narrow as 90 feet (27.4m) wide, and can complete a 180-degree three-point "star" turn within 80 feet (24.4m). Also, when fully loaded, the aircraft is capable of backing up a 2 percent gradient slope using the directed flow thrust reversers.

Short TakeOff and Landing (STOL) capability is achieved when the trailing-edge flaps are extended into the exhaust flow from the engines during takeoffs and landings. The engine exhaust is deflected downward by the slotted-flaps to augment the

wing lift. This allows aircraft with "blown flaps" to operate at roughly twice the lift coefficient of that of conventional jet transport aircraft.

An-124-100 is not able touse short airfields, but the multi-wheel landing gear with rough-field capability, two APUs and mechanized loading enable independent operation of the aircraft from poorly equipped airfields.

3.4.2 Autonomous Ground Operations

Once on the ground, the A400M is designed for very rapid and autonomous cargo loading or unloading without any specialized ground support equipment. Fitted with on-board 32-tonne capable powered winch and an (optional) five tones / 11,000 lb capable crane to load directly from ground level, the cargo hold is optimized for single loadmaster operation from a computerized workstation, where the loadmaster can pre-plan loading from a loads data base. Furthermore, the A400M's landing gear can "kneel" down in order to reduce the angle of the ramp facilitate the off- and on-loading of material. This allows loading and unloading without ground assistance at the most remote and austere strips, minimizing vulnerable time on the ground. This reduces the aircraft's vulnerability to hostile action, hence increasing its survivability. The A400M can also conduct cross-loading with other strategic transports without the need to reconfigure loads in 'hub and spoke' operations.

The aircraft can operate into and out of problematic sites such as those surrounded by inhospitable terrain or made difficult by adverse weather conditions. The fully-integrated, electronic flight-deck and the advanced cargo-handling systems allow a basic crew of only two pilots and one air loadmaster to operate the aircraft. On the ground, the aircraft can be turned in a very small radius and its four Pratt & Whitney engines are fully reversible, giving it the ability to maneuver into and out of restricted parking or freight-offload areas at undeveloped strips. This enables the C-17 to deliver cargo to small airfields with limited parking space in a shorter time, so increasing throughput where time on the ground is kept to a minimum.

3.5 Air-to-air Refuelling

3.5.1 Air-to-air refueling systems

Air-to-Air Refueling can be done either through two wing mounted hose and drogue under-wing refueling pods or through a centre-line fuselage refueling unit (FRU). Its built-in air-to-air refueling capability allows it to be rapidly re-configured to become a tanker. With hard points, fuel lines and electrical connections already built into the wings, it takes under two hours to convert the A400M from an airlifter into a two-point tanker aircraft.

The two hose and drogue under-wing refueling pods can provide a fuel flow of up to 400 US gal / 1,500 liters per minute to receiver aircraft. Refueling can also be done through a centre-line Hose and Drum Unit (HDU) which provides a higher fuel flow of some 600 US gal / 2,250 liters per minute. Three video cameras can also be installed, to monitor the refueling from the wing pods and the centre-line unit.

C-17 Globemaster is equipped with a boom designated for air to air refueling and doesn't have tanker capabilities.

3.5.2 Refueling any type of aircraft and helicopter

The A400M is the only Tanker which can refuel the entire range of probe-equipped military aircraft at their preferred speeds and altitudes. This is because it can

fly both at the low speeds and low altitudes typically used to refuel helicopters (roughly 110 knots and 5000 feet)(, as well as at higher speeds and altitudes of about 290 knots kt and altitudes around 25,000 ft which are typically used for refuelling of fast jets, such as fighters or large aircraft (such as the C295, C-130 Hercules, Eurofighter, F/A-18 Hornet or Rafale,) or even another A400M for buddy refueling. To do so, the A400M receiver is equipped with a refueling probe mounted above the cockpit. This increases the range and endurance of the A400M. The probe can easily be removed when it is not needed.

3.6 Operational Flexibility

3.6.1 Air Drop

The A400M excels in the airdrop role, being able to drop from both high and low altitudes, (as high as 40,000 ft for special forces' operations, and as low as 15ft for low level load deliveries). With the new A400M, which can carry more paratroopers than other Western-built military transport, Airbus Military is setting new standards in paradropping operations.

The A400M can accommodate up to 116 fully equipped paratroopers, carrying them to the drop zone at speeds up to 300kt, but dropping them at as little as 110kt to ensure minimum dispersion. Crucially, two streams of paratroopers can jump simultaneously from the ramp or the two side doors to further cut jumping time and scatter. Careful aerodynamic design reduces turbulence behind the aircraft and deployable baffles at the door exits protect jumpers from the airflow. The aircraft is also fitted with a winch, allowing any ´hung-up´ static-line paratrooper to be safely retrieved. The type's low speed characteristics make the A400M ideal for dropping supplies from low altitude. The A400M can assure a very rapid and direct response to any occurrence, making it the ideal tactical airlifter. The A400M can airdrop up to 25 tones / 55 100 lb of containers or pallets through gravity and parachute extraction. The Computed Air Release Point (CARP) linked to the Automated Release System, automatically computes the release point for optimum delivery accuracy, including corrections for wind effects.

By 1999 the Air Force was upgrading the C-17s capability by developing a new air drop system that increased its cargo air drop capacity by 266% and reduced by 30% the total number of C-17 aircraft required for strategic brigade airdrop. The system called Dual Row Airdrop System (DRAS) delivers equipment more safely and efficiently than the older single row airdrop system. The new system allows two rows of equipment to be airdropped from the C-17s; this brings more than doubles the capacity of each C-17 and cuts in half the number of C-17s required to airdrop.

3.6.2 Medical Evacuation

The A400M is equipped with eight stretchers as standard which are permanently stored on board, but it can accommodate as many as 66 standard NATO stretchers and 25 medical personnel seated on troop seats. It has the range, speed, operating altitude and comfort to optimally serve the medevac role

The C-17 aircraft can transport litters and ambulatory patients during aeromedical evacuations when required. A basic crew of five (two flight nurses and three medical technicians) is added for aeromedical evacuation missions. Medical crew may be altered as required by the needs of patients. The aircraft can accomodate 36 litter and 54 ambulatory patients and attendants

3.7 Cost Effectiveness

3.7.1 Reliability

The A400M has been designed to be the most reliable airlifter ever. By using proven Airbus commercial design concepts and tools, its availability benefits from high component reliability. Its new maintenance concept, which is largely inspired from commercial civil airliner experience, will translate into a very high dispatch reliability of 98.7 per cent at entry into service. This will dramatically reduce life cycle costs. Over twelve years of operation, the mandatory heavy maintenance "down-time" will only require the A400M to be on the ground for only 84 days in total.

Reliability and maintainability are two outstanding benefits of the C-17 system. Current operational requirements impose demanding reliability and maintainability. These requirements include an aircraft mission completion success probability rate of 92 percent, only 20 aircraft maintenance man-hours per flying hour, and full and partial mission availability rates of 74.7 and 82.5 percent, respectively. The Boeing warranty assures these figures will be met.

3.7.2 Life Cycle Cost and Productivity

Thanks to its superior performance and capabilities, a fleet of eight A400Ms offers the same productivity (measured in tones per nm each year) as a fleet of eighteen previous generation tactical airlifters.The Life Cycle Cost of these eighteen previous generation tactical airlifters is 55% higher than the one of the eight A400M fleet and they are unable to transport outsize loads such as helicopters or armored vehicles including Mine Resistant Ambush Protected (MRAP) vehicles, which can be transported by the A400M.

The original specification from McDonnell Douglas defined for C-17 Globemaster III a service life of 30,000 hours.

4. Conclusion

All three programme presented in this paper are an example of multinational cooperation, where nations that are signatories to the MOUs contribute funding on a cost-share basis. The main difference between all three programmes consists on type of contract the participant nations have signed to fulfill their need of strategic airlift flying hours.

The SALIS Programme is similar with a lease contract for which participant nations have contracted up to six An-124-100 aircraft and their cost-share covers both administration and operating. The Programme proved the participants expectation and seems to be the most effective interim solution to satisfy the need of strategic airlift, but the programme is restricted in term of flexibility and control of the assets in crisis situations.

The SAC Programme is more appropriate by an off-the-shelf purchase contract for which the signatory nations have purchased their own assets and decided to share the acquisitions and operating cost in order to take advantage and to satisfy the national need of strategic airlift. The Programme is a successful example of pooling and share and matches perfectly the new NATO strategy even the programme is acting outside of NATO umbrella. By comparison with SALIS Programme for which the participants committed themselves for three years with possibility to extend the contract, the SAC MoU signatory nations have committed themselves for 30 years with the possibility of extension is the service life of C-17 Globemaster III aircraft will be extended.

The A400M Programme is a joint contract on which the participant nations have decided to invest in a new type of strategic airlift capability in order to fulfill their need of tactical and strategic airlift and also to replace their aged fleet of C-130 aircraft. The A400M Programme is also a combination of political, industrial and economic commitment through which more than 10000 European jobs will be supported and re-establishes European skills in large military aircraft industry. One of the bigger advantages of the A400M is that it was designed to meet the requirements of eight European Air Forces, which means an important step forward in standardization of Europe's fleet of tactical transport. Moreover, this will provide for an improved interoperability level and the option of consolidating major maintenance operations in a joint industrial consortium.

Taken in consideration the capabilities used by all three programmes we conclude that, the C-17 appears to have several advantages over the Antonov in terms of performance. First, the C-17 can land on short, unpaved, austere runways, while the Antonov, mainly due to its size, is restricted to large airfields and long runways. Second, the Boeing aircraft has defensive aids and self-protection measures, which the An-124-100 does not, being a commercial variant of a military aircraft. Therefore, the Antonov is not suitable to operate in hostile environments. Third, the C- 17 has an advantage in terms of operational and technical reliability, while the An-124 is not NATO-certified to carry passengers. On the other hand, the Antonov is twice as large as the C-17 and, therefore, can fit more loads.

The A400M's capacity puts it between the C-130 and the C-17 and way below the Antonov. The size of the A400M's cargo compartment and volumetric capacity is two thirds that of the C-17 and double that of the C-130J. But, when we talk about the performance, the A400M is the most advanced military airlifter, fully equipped and able to perform three different types of missions: tactical, strategic and air-to-air refueling. The A400M has been rigorously designed to meet the equipment transport needs of modern armed forces. The A400M can perform missions which previously required two - or more - different types of aircraft.

5. References:

[1] Vasilescu, Cezar *Smart Defence – Strategic Airlift Capability: From Theory to Practice*, http://journal.dresmara.ro/issues/volume2_issue2/07_vasilescu.pdf
[2] Novotny, Antonin *Smart Defence – A New Way of Looking at The Capabilities of the Alliance*, http://cenaa.org/analysis/smart-defence-a-new-way-of-looking-at-the-capabilities-of-the-alliance/
[3] Airbus Military *The Pocket Guide to A400M – The Versatile Airlifter,* March 2008
[4] Boeing Company *C-17 Globemaster III – Pocket Guide*
[5] https://www.heavyairliftwing.org/en/Pages/SAC-Governance.aspx
[6] http://www.abcdlist.nl/a400mf/a400mf.html
[7]http://www.defense-aerospace.com/articles-view/feature/5/144962/airbus-aims-at-huge-a400m-export-market.html
[8] http://www.raf.mod.uk/equipment/c17aglobemaster.cfm
[9] http://www.iss.europa.eu/uploads/media/Alert_45_Heavy_Airlift_Wing.pdf
[10] https://www.heavyairliftwing.org/en/Pages/The%20Strategic%20Airlift%20Capability.aspx
[11] http://www.occar.int/338

[12] http://www.aicgs.org/issue/natoeu-cooperation-with-russia-on-military-airlift/
[13] http://theaviationzone.com/factsheets/c17.asp
[14] http://militaryaircraft-airbusds.com/Aircraft/A400M/A400MAbout.aspx
[15] http://www.globalsecurity.org/
[16] http://planes.axlegeeks.com/l/245/Antonov-AN-124-100-Russian
[17] http://www.antonov.com/aircraft/transport-aircraft/an-124-100-ruslan
[18] http://airvectors.net/avc17.html
[19] http://www.nato.int/docu/update/2006/03-march/e0323a.htm
[20] http://www.nato.int/cps/en/natohq/news_7826.htm?selectedLocale=en
[21] http://www.nato.int/cps/en/natohq/topics_49137.htm
[22] http://www.nato.int/cps/en/natolive/topics_50106.htm