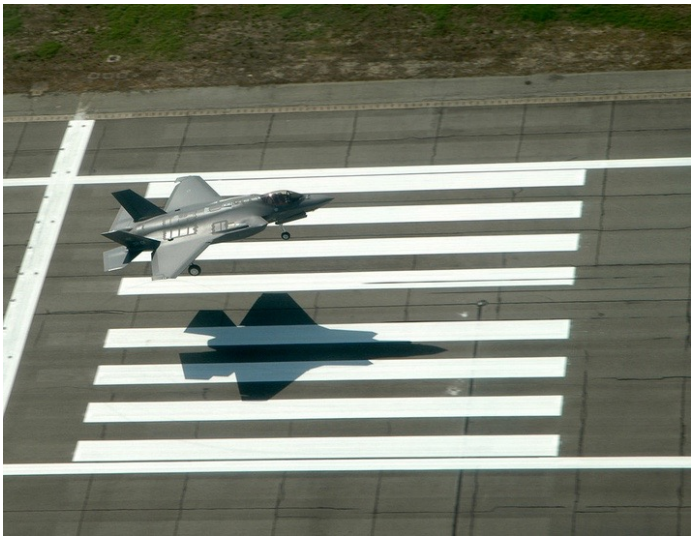
SHAPING THE FUTURE OF ITALIAN AIRPOWER



10/13/15

Second Line of Defense

Shaping the Future of Italian Airpower

SECOND LINE OF DEFENSE

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INTRODUCTION

The Italians, like the British, are undergoing a double transition, whereby the Eurofighter is being modernized in two ways: namely, subsuming air-to-ground missions and facilitating the transition in the replacement of the Tornado by adding a new AESA radar to the airplane, and introducing the F-35 to help shape joint force transformation.

In the Italian case, the new Cameri facility is a key element for the Italian Air Force. Located on an Italian Air Force base used for logistics, the Italian government under the management of Alenia Aermacchi (AAeM) has built a 22 building facility to support the F-35 program.

The support comes in three parts.

First, there is a Final Check Out and Assembly facility, where there is the possibility for assembling Italy's As and Bs, as well as other European F-35 partners, initially the Netherlands.

Second, there is a wing construction facility with Italy building a minimum of 835 full wings for the F-35 global program. The first wing has already been installed on a USAF F-35.

Third, with the 22 buildings of more than a million square feet of covered work space comes significant space to build out support for F-35s operated by the US and allies in Europe.

With the Mediterranean and the Middle East as a busy operational area, the Cameri facility can provide significant operational support to the F-35 fleet operating in the area.

In fact, Italian industry is well positioned as a member of the Eurofighter consortium, the F-35 global enterprise, and the builder of a new trainer aircraft and related training facilities, to support 21st century air operations.

THE FIRST FLIGHT AS A KEY BASELINE EVENT

The F-35 is not simply a replacement aircraft, but it is a global aircraft.

And with the allies buying around 50% of the aircraft over the next few years, while Washington sorts out its strategy, the innovation driven by the allies will be significant as well.

Recent visits to Australia have highlighted that the RAAF is in the throes of shaping a transformation strategy shaped in part around the coming of the F-35.

But what can be missed are the impacts of other allies and their efforts for transformation associated with the F-35. For example, the RAF is engaged in a double transition – Typhoon subsuming Tornado with F-35s coming to the force.

This double transition is a compressed version of the broader topic of 4th/5th generation transition similarly to what the Italian Air Force is doing and the interaction between the RAF and the IAF could be a good driver for change.

This means that the Italian and British opportunity for leadership is clear in a challenging period of airpower history. The clear advantage of a global transformation enterprise associated with the F-35 is that transformation in airpower does not simply depend on the United States, nor weighed down by a number of U.S. legacy discussions, which impede change.

With regard to the Italians, they have proven to be forward leaning in spite of all the fiscal and political challenges, which is an amazing achievement. And the industrial and technological aspects of the Italian achievements are significant as well.

At the Copenhagen airpower symposium this spring, a senior Dutch Air Force officer, underscored how significant the change on the Italian side was from his point of view.

At the Centre for Military Studies-Williams Foundation Airpower Symposium held in Copenhagen on April 17, 2015, Air Commodore Dré Kraak, from the Royal Netherlands Air Force, discussed the way ahead with regard to training for the Dutch Air Force and highlighted an important evolving coalition relationship with Italy.

The Air Commodore went out of his way to praise the Italians, who in his words, "have seen dramatic progress in their aerospace production capabilities over the past twenty years."

He started his presentation by highlighting that the Dutch selection of the F-35 was a no brainer.

It was by far the best aircraft in the competition.

Without any doubt, without any doubt operationally, the F35 is the best airplane ever.

And anybody that chooses something else– it's probably a political choice and not a decision being made by a fighter pilot.

There's no fighter pilot in the Dutch Air Force that does not think that the F35 is the best aircraft in the world at this moment.

http://www.sldinfo.com/another-coalition-airpower-dynamic-training-for-next-generation-aircraft/

Not only will Italy build the bulk of the Dutch F-35s, but they are also emerging as a key partner in possible training solutions as well.

http://www.sldinfo.com/italy-and-the-netherlands-sign-agreement-for-pilot-training/

In a key moment for European-American combat airpower collaboration, the first F-35 built outside of the United States flew from Cameri on September 7, 2015.

The aircraft, designated AL-1, is the first of eight aircraft currently being assembled at the Final Assembly and Check Out (FACO) facility at Cameri, in northwestern Italy. During the flight, that lasted about 1,5 hours, the F-35A was escorted by a Eurofighter Typhoon.

Italy's first F-35A Lightning II, known as AL-1 and assembled at the Cameri Final Assembly and Check Out (FACO) facility, flew for the first time today marking the program's first-ever F-35 flight outside the United States.

Lockheed Martin F-35 test pilot Bill "Gigs" Gigliotti, lifted off the runway at 1:05 p.m. European Standard Time for a 1:22 hour check flight in AL-1 marking a historic milestone for Italy, Finmeccanica-Alenia Aermacchi manufacturing cooperation and Lockheed Martin.

"The first flight of AL-1 is a monumental achievement thanks to the hard work and dedication of our Finmeccanica-Alenia Aermacchi and Lockheed Martin teammates," said Lorraine Martin, Lockheed Martin F-35 Program General Manager. "Italy's 'primo volo' (first flight) sets a firm foundation for Italy's F-35 program and future opportunities for the Cameri FACO. My heartfelt congratulations to all who worked tirelessly to bring us to this major international program milestone."

Today's first flight for AL-1 went as planned. "As expected, the jet performed exceptionally well and without any surprises," Gigliotti said. "I'm honored to have flown AL-1 on its maiden flight and grateful to the Cameri team for providing a great jet.

We look forward to continued successes leading up to aircraft delivery later this year."

The Cameri FACO is owned by the Italian government and operated by Finmeccanica-Alenia Aermacchi in association with Lockheed Martin. The Cameri FACO's F-35 production operations began in July 2013 and 'rolled out' Italy's first F-35A aircraft, AL-1, in March. AL-1's official delivery to Italy is expected by the end of the year.

The facility will assemble both Italy's F-35A conventional takeoff and landing variant and the F-35B short takeoff/vertical landing variant, and is planned to assemble the Royal Netherlands Air Force's F-35A aircraft in the future.

The F-35A and F-35B will replace Italian Air Force and Italian Navy AV-8 Harriers, Panavia Tornados and AMX fighters.

In addition to its responsibility in the operations of the FACO, Finmeccanica-Alenia Aermacchi also produces the F-35A's full wing-sets.

The work contracted to Finmeccanica-Alenia Aermacchi, a strategic co-supplier of F-35A full wing assemblies, is one of the largest manufacturing projects for the Italian F-35 program, with 835 full wing assemblies planned. Finmeccanica participates in the F-35 program also with Selex ES, responsible for various onboard electronics.

The F-35 Lightning II, a 5th generation fighter, combines advanced low observable stealth technology with fighter speed and agility, fully fused sensor information, network-enabled operations and advanced sustainment. More than 130 production F-35s have been delivered to customers and have flown more than 38,700 cumulative fleet flight hours, fleet-wide.

http://www.lockheedmartin.com/us/news/press-releases/2015/september/ItalyF35FirstFlight.html

The F-35 program has been built around a very different manufacturing model for fighter jets, more modeled on what an Airbus would do than the more traditional station build approach.

The F-35 is to be built on three final assembly lines (FALs)– Fort Worth, Cameri, and next year in Japan.

The line in Fort Worth is a pulse line, meaning the planes move on the line through their full build. Currently, the planes move, about five days through the line during their 20 months on the line. Three configurations are built on the single line – F-35As, Bs, and Cs – as well as modified allied versions of those aircraft, such as the drop chute on the Norwegian F-35A.

The aircraft is built on a digital thread foundation, meaning that digital systems are crucial to the supply chain and component builds and for the final assembly of the components, as well as for the maintenance of the plane.

As Donald Kinard, a key F-35 manufacturing expert, put it in an interview earlier this year:

Question: What is the impact of having two other national approaches to final assembly?

Kinard: They see things differently.

The Italians have seen the way we build the airplane and we see how they build the aircraft.

Technically we build the aircraft the same way but improvement ideas come from all of the participants.

I'm the collector of those lessons learned from all the sites and so it's been real interesting to see the feedback we've received.

One of the strengths of the program from inception was the incorporation of technology and knowledge from all of the partners.

Of course, the Italians and Japanese are building a lot different quantities than we are.

The Italian FACO is going to be two a month, the Japanese FACO is going to be at most one a month.

With those kind of numbers, they're not doing it exactly the way we are. They're not going to have a pulse final assembly line, for example. They're probably going to have a station build line, but those are all things that you would do.

Our line is established for quantity build and if I was building one a month I might not pulse them either as it costs money to move them.

But overall, we are now in the manufacturing phase, which I might call, taking it to the streets.

Meaning we're taking a digital thread to the workers on the floor. And moving forward as well we'll eventually take this right to the maintainers.

A lot of things we're doing in a production floor will eventually be a bonus for the maintainers who work on the airplane.

For example, we can set up a portable optical projection system, and one can project work instructions directly onto the airplane that he's working on.

The fidelity of what he sees and can focus his attention on is ramped up.

The interactivity among the suppliers, the FAL and the maintainers is much simpler because we can talk to each other from long distances away using the digital thread too.

And changes in the production process software are already cross-fertilizing with the maintainers.

For example, in the transition from LRIP-5 to LRIP-6 software, we introduced more functionality into the Prognostic Health Management (PHM) system.

We then used the PHM improvements in the production process to get what we call network status of for our combat mission systems.

From a production point of view, we get a lot of information as we're building the airplane in terms of how well every system is working.

And the PHM is going to continue to get better as we go through the different software lots as well.

The software changes have helped the pilot, but it's also helped us build the airplane because we were historically using very manual techniques to go troubleshoot problems.

With the software enabled process and airplane, we have significant situational awareness (SA) of the airplane, not just for the pilot flying the airplane but for the supply chain, the FAL and the maintainers.

As Secretary Wynne, the man who started the talks on building the Italian facility with the Italians put it with regard to the importance of the event:

"This flight makes the F-35 truly an international program."

THE ITALIAN AIR FORCE SHAPES A WAY AHEAD: THE PERSPECTIVE OF THE ITALIAN CHIEF OF STAFF

At the beginning of the 20th Century, Italy was a pioneer in combat aviation. Although different at the beginning of the 21st century, Italy has again emerged as an important player in military aviation. They are key players in the two key 21st century multinational military aviation industrial coalitions, Eurofighter and F-35, as well as establishing a center of excellence for pilot training along with introducing one of the best 21st century trainers, the Aermacchi M-346.

In late September, in the famous Italian Air Ministry building in the center of Rome, *Second Line of Defense* conducted its third interview with Lt. General Preziosa, the Chief of Staff of the Italian Air Force. Italy is the only NATO Air Force to have performed all NATO Interim Air Policing (IAP) missions in Slovenia, Albania, Iceland and the Baltic.

According to Lt. General Preziosa, with regard to the Italian role in the NATO air policing mission earlier this year:

"We had four aircraft operational 24/7 for the Baltic Air Policing mission, but that meant we had to have other aircraft available, more than 100 personnel operating locally and reachback to Italy for logistical support. This also required us to pay attention to air defense and provide modern air defense support to our Eurofighters.

We use a messaging system to support our Eurofighters and not radio communication from the ground; the Lithuanians did not have such a system, so we needed to install it and operate during our time in the Baltic Air Policing mission."

This put the Italians up on a regular basis against Russian aircraft, where the Russians test and probe Western defenses and various capabilities, including electronic warfare systems.

Italy has also recently announced a successful negotiation with Kuwait to buy 28 Eurofighters (22 single seaters and 6 double seaters), which was negotiated directly by the Italian state with Kuwait.

With regard to the Kuwait sale, Preziosa noted that the Kuwaitis were clearly aware of the work, which the RAF and Italy were doing to ensure that F-35 and Eurofighter would be able to work together. They also focused upon the training infrastructure in Italy and the maturity of the Eurofighter support structure as important elements of down selecting the Eurofighter for the Kuwaiti Air Force. And, of course, the Saudi use of Eurofighter and their own positive views of the Saudi experience in current Middle Eastern operations played a part as well.

The Italians have shaped a good reputation for pilot training, and recently the Dutch signed an agreement with Italy to train their pilots and this together with the Kuwaiti buy have brought outside confirmation of that reputation.

The Italians have broadened their air competencies as well as coalition contribution by operating Predators as well. The Italian Air Force deploys a Remotely Piloted Aircraft Wing, namely the 32nd Wing. The 32nd wing

of the Italian Air Force, operates the remote controlled aircraft known as Predator, and completed their first tasking with the EU Naval Force in September 2014 while based in Djibouti.

The Predator enterprise (if one might call it that) had already shaped ways to share data, and the data sharing arrangements with Predator presaged some of the ways the F-35 fleet will also share data. According to Preziosa, "Predator is an important building block moving forward in 21st century air operations, and our data sharing capabilities have provided crucial information to shape combat decisions."

And the Italians have built a significant facility at Cameri air base to build the F-35, wings for F-35s and to provide sustainment for the operational fleet throughout the region as well. Recently, the first F-35 came off of the Cameri line and flew successfully in Italian Air Space. The facility was built in only four years and the first flight was ahead of schedule.

Lt. General Preziosa noted "the quality of the aircraft which has come off of the Italian line clearly demonstrates the competence of our industry and the importance of our strategic partnerships with U.S. and global defense industry. The fact that the Dutch Air Force will buy planes from the Italian line is also a recognition of the quality of the Italian effort."

For Preziosa, the F-35 is really a different type of plane, probably not well captured by the term fifth generation aircraft. "The F-22 and the F-35 are called fifth generation aircraft, but really the F-35 is the first airplane built for the digital age. It was conceived in and for that age, and is built around the decision tools in the cockpit and is in fact a flying brain. And that makes it different from other aircraft.

It is a multi-tasking aircraft, and fits well into the I-phone age. Other aircraft – with the exception of the F-22 – are built to maximize out as multi-mission aircraft, which execute tasks sequentially and directed to do so.

The F-35 fleet thinks and hunts and can move around the mission set as pilots to operate in the battlespace leverage the data fusion system. It is a battlespace dominance aircraft; not a classic air superiority, air defense or ground attack aircraft. It changes the classic distinctions; confuses them and defines a whole new way to look at a combat aircraft, one built for the joint force age as well.

For the Army and the Navy will discover as the F-35 fleet becomes a reality, how significant the F-35 is for their combat efforts."

He also discussed the key relationship with the Royal Air Force, for both Air Forces are working a similar transition. For Lt. General Preziosa, the close relationship with the RAF was important in working through the way ahead with regard both to Eurofighter modernization and working with the F-35.

"There is no point in having to repeat lessons which have been learned by one Air Force or the other."

For Lt. General Preziosa, the Eurofighter is an excellent aircraft but will be modified to work more effectively with the F-35 in operating in the 21st century battlespace. The payload evolution of the Eurofighter is significant, and weapons modernization will support both the F-35 and the Eurofighter in providing new tools for the tool kit for air operations.

In effect, the two planes will work together in shaping along with other allied assets a 21st century air combat choreography within which weapons modernization and other assets will be woven in over time for the U.S. and its allies to remain ahead in the inevitable competition with adversaries.

"There is nothing static in airpower; there is always a fluid dynamic, and the F-35 provides a benchmark for now for air power excellence and for several decades moving ahead we will leverage the decision tools and multi-tasking capabilities of the F-35 as well add capabilities to our Air Forces."

Despite the economic challenges and the political dynamics within Europe, Italy is well positioned to support 21st century air operations. This is an evolving dynamic, one, which will require continuing leadership within Italy such as Lt. General has provided.

ITALIAN AIRPOWER MODERNIZATION: A DISCUSSION WITH THE EDITOR OF RIVISTA ITALIANA DIFESA

Recently *Rivista Italiana Difesa* (RID) published one of the most comprehensive looks at the F-35 as a combat capability published in any language; but this was published in Italian as a Special Supplement. In an interview with the editor of RID and the author of the report, he provided an overview of the synergy of the F-35 with the Eurofighter and the evolution of Italian airpower.

Question: You are the editor of RID.

Could you describe the focus of your magazine and your background as well?

Pietro Batacchi: Rivista Italiana Difesa is the leading Defense magazine in Italy and one of the most important in Europe. It deals with the full spectrum of Defense issues and is well established in Italian Defense community after 33 years of editorial activity.

Regarding myself, I have a degree in political science. After the University I attended a Strategic Study Advanced Course at the Defense High Studies Center in Rome and then I got a PHD in International Relations.

Question: From your vantage point, you are in a good position to describe Italian, European and global military aerospace trends.

What are the major findings and conclusions of your Special Report?

Pietro Batacchi: The main finding of my study on the F-35 was very simple. The F-35 provides the Italian military with a strategic instrument/aircraft able to penetrate not only permissive but disputed airspace thanks to its low observability or to ensure greater operational flexibility allowed by its "net-centric" and open architecture.

In addition we can talk about the great internal fuel capability that offers to the aircraft an enormous autonomy and operation persistence, much greater than the ones normally experienced by a fighter aircraft.

Due to all these reasons the aircraft manufactured by Lockheed Martin gives to the political leaders the opportunity to join a conflict from the very early stages, with a clear political and strategic return, and to increase their diplomatic options.

Question: For both the UK and Italy, the shaping of a 21st century air combat force is being built around the introduction of the F-35 twined with the modernization of the Eurofighter and both the RAF and the IAF are working with each other to shape a path forward.

How would you describe the role of Eurofighter modernization and its interaction with the coming of the F-35 fleet?

Pietro Batacchi: The modernization of the Eurofighter can be considered incremental. The aircraft was born as a pure air superiority fighter designed to deal with the threats of the Russian aircraft during the Cold War.

Over the years the requirements have been changed and today, thanks, for example, to the Phase 1 Enhancement Program (P1E), the Eurofighter Typhoon has evolved in a modern swing role aircraft able to find and attack ground targets.

This evolution process will continue with P2E, including the integration of the Meteor and Storm Shadow missiles, and with the integration of the CAPTOR-E AESA radar in the next years that will definitively complete the growth of the aircraft.

Ultimately, the two aircraft can be considered highly complementary and perfectly tailored to a military more and more expeditionary and projection oriented as the Italian one.

After all, when the Italian Defence White Paper talks about a "Regional Full Spectrum" military, it means a military able to intervene in all the Mediterranean scenario also in high intensity conflicts under which both F-35 and Eurofighter Typhoon are best suited if employed together.

Question: And the Eurofighter recently has seen a success in the sale of aircraft to Kuwait. The agreement was negotiated by the Italian government.

The Italian Air Force has operated frequently from Kuwait.

What role do you see the IAF's impact on Kuwait might have had on the Kuwaiti decision?

Pietro Batacchi: The Italian Air Force and Ministry of Defense in general had a great role during the bargaining bringing to the successful outcome of the Kuwait's campaign. As Italian Defense industry can confirm the Italian Defense was very important in providing it with a great support and exploiting the channels with Kuwait opened since the first Gulf War in 1991 joined also by the Italian military and Air Force.

Question: From an industrial point of view, the modernization of a legacy asset like Eurofighter along with the innovations driven by shaping a fifth generation warfare capability associated with the F-35 fleet will provide a rich area to shape new approaches to capabilities going forward.

How do you see this interactive combat modernization space shaping up going forward?

Pietro Batacchi: Also regarding the industrial point of view, the two aircraft can be considered fully complementary. The Eurofighter provided the Italian and the European industry more in general with a high quality involvement as the program allowed Italy to develop new technologies that before were not available in Europe.

At the same time, the industrial participation in the F-35 program brought in Italy an advanced industrial process in which all the components and parts have to be perfectly produced and in which the tolerances must be more than narrow. This aspect was fundamental for the Italian industry which now can replicate this process in the future aeronautical programs starting, for example, from a new fighter aircraft that could be manned or unmanned.

Notably this is true with regard to missiles. Indeed, the first new fifth generation missile is Meteor which is clearly the first of several new missiles to follow drawing off the fifth generation warfare transition.

How do you see the future of the evolution of missiles driven by the evolving concepts of operations?

Pietro Batacchi: The Meteor missile will provide Eurofighter with Beyond Visual Range capability that is crucial in the modern air-to-air combat scenarios where the probability of the so called dog fight are more and more lower. In addition we have to consider the importance of the advanced data link that together with new open

architecture of an air-to-air missile can allow to change mission and target during the flight and get in this way greater flexibility in the engagement.

Question: Finally, Italy is well positioned in terms of building and supporting 21st century combat forces.

At Cameri you are building the new generation aircraft. Italy is also building some additional Eurofighters but over the next decade the effort will focus on MRO or sustainment and modernization of the Eurofighter fleet.

And Italy has a 21st century fighter, the Aeromachi M-346.

How do you see the Italian industrial position and its advantages moving forward?

Pietro Batacchi: The Italian aerospace industry is well positioned for the future challenges. It gained a great experience during the past with important program such as the Tornado, the Eurofighter and now wit the F-35. In addition the Italian defense industry has a long standing tradition in some excellence sectors as, for example, in the trainer sector as you mentioned or in the missile sector or in the electronic warfare systems field. So the Italian industry has all the competencies needed to see to the future with optimism and to continue to play a key role in Europe.

RESHAPING CONCEPTS OF OPERATIONS: EUROFIGHTER, THE F-35, THE UK AND ITALY

Both the UK and Italy will operate a mixed Eurofighter and F-35 fleet. Both have operated the Tornado, which is reaching the end of its service life. Both will sort through evolutions of the Eurofighter to encompass some of the mission sets for Tornado as the Tornado is retired and as the F-35 comes into the two fleets and provides the next surge for the re-working of air-led combat concepts of operations.

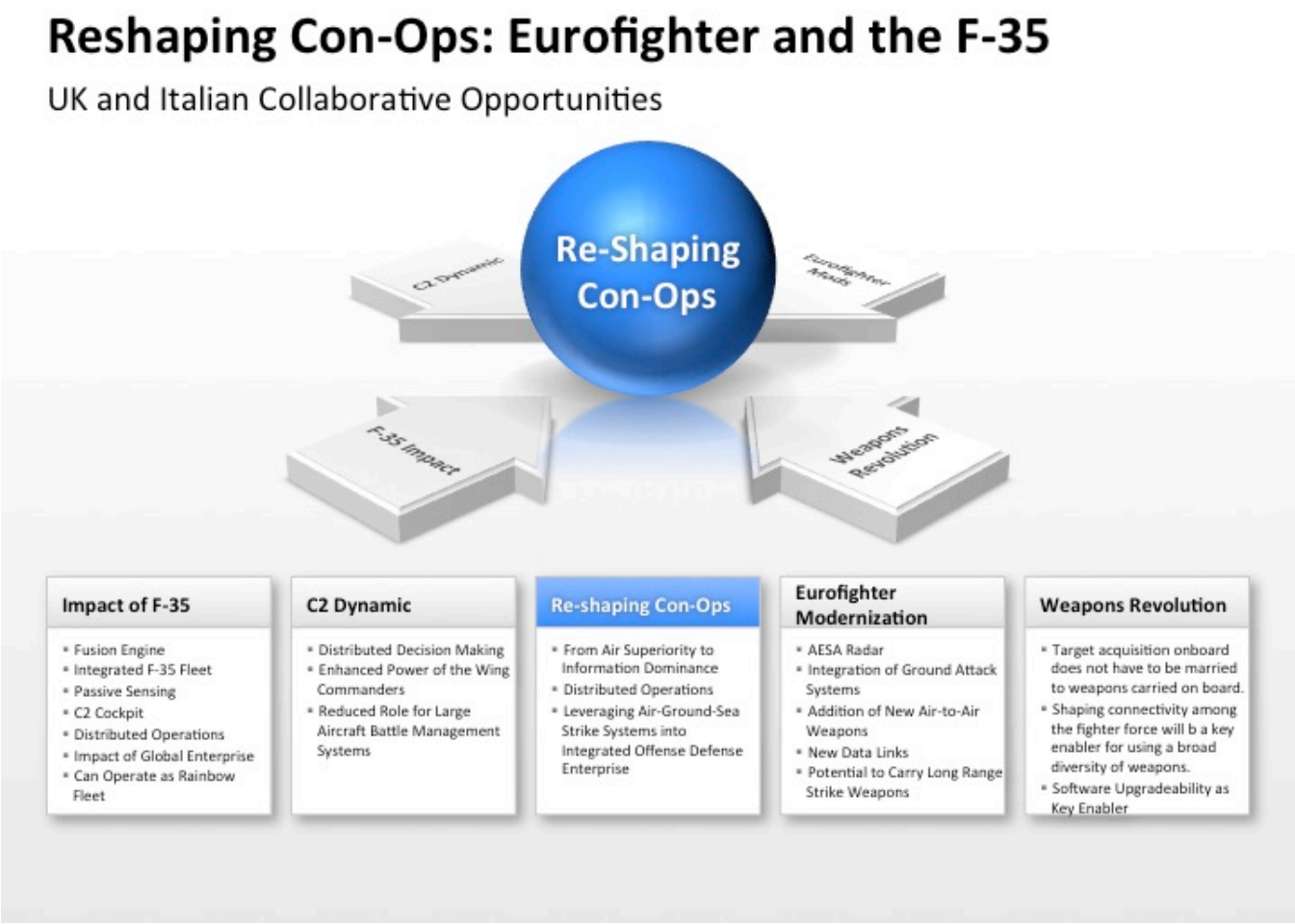
A key element of this transformation will be reworking the connectivity among air, sea and ground systems as well as shaping the weaponization approaches of joint and coalition forces.

In part, this is a Eurofighter transition whereby the radars are upgraded, and weapons added; in part this is the coming of the F-35 and its impact on reshaping air enabled combat operations.

And associated with this will be fundamental changes over time in C2, and the approach to strike operations.

The UK and Italy already fly together in operations through their use of Tornados and Eurofighters and have clearly shared combat learning with regard to the use of these platforms; as the F-35 comes on line this combat learning cycle will continue into the next generation of aircraft, and shaping ways to approach fifth generation warfare.

In effect, the dynamics of change for Italy and the UK will be a function of the intersection of four variables: the evolution of the Eurofighter; the impact of the F-35 and the global fleet of F-35s; changes in weaponization, and evolving C2 for strike and combat operations.



There is an inherent possibility that the UK and Italy could provide an important force for synergy in shaping concurrent approaches to evolving concepts of operations. Of course, this depends upon how effective their working relationship is and how effective cross-MOD, and cross-industrial relationships are in leveraging their working relationship.

And the two countries can play an important role as well with the European Air Group (EAG), the only multinational organization that focuses solely on airpower and its evolution. Recently, the EAG which has been a fundamental element of shaping the European Air Transport Command and the creation of the European Personnel Recovery Centre, has started to look for the Air Chiefs of the seven European Air Forces for whom they work at the integration of 4th and 5th generation aircraft. And the EAG has a Typhoon integration group as well.

Clearly, Italy and the UK can play an important role working through the challenges and the opportunities based on the evolution of Eurofighter while the F-35 is introduced.

And both will be operating F-35Bs from sea bases so can lead in shaping an understanding of how sea-based and land-based air can work together to great a significant operational effect as well.

The Reconfiguration of Eurofighter

The twin dynamics of the retirement of the Tornado and the arrival of the F-35 pose a significant challenge as well as opportunity for both the UK and Italy. And shaping effective responses to this challenge can open prospects of innovation for other Eurofighter users as well.

Although operational needs have kept moving the Tornado retirement date to the right, the scheduled date is 2019 for the RAF. Italy will be a bit further down the road and retire their Tornados with 5 years after the intended RAF retirement date.

As one UK Typhoon pilot put it: "There is a clear need to expand the effects of Typhoon operations and here the enhancement of its weapons package will be an important improvement."

To take up some of this role the Eurofighter is being reconfigured to provide an enhanced capability for the ground attack role, over and above the austere level of Enhanced Paveway II integration that was used by the RAF during the Libya campaign. Paveway 4 is being integrated in P1E and then further weapon capability, primarily from MBDA, is being integrated, some of which are currently carried by Tornado.

The Tornado carries both Storm Shadow and Brimstone and both are being shaped for integration onboard the Eurofighter. The integration of the Storm Shadow on Typhoon is being driven in part by funding from the Middle East, notably Saudi Arabia that wants its Typhoons to have a cruise missile carrying capability, and when married with its new air tanking capability can enhance the strike range of its Typhoon force.

Brimstone 2 is designed to operate against maneuvering surface targets on land or sea. It is a low collateral, close air support weapon and has been combat proven by the RAF in both Afghanistan and Libya. It will greatly enhance the effect of the Eurofighter as well.

And the modernization package for the Eurofighter radar will allow the integration of Storm Shadow and Brimstone 2 to be more effective as well.

As Alan Tovey in the Daily Telegraph highlighted the synergy between weapons modernization and radar upgrades:

The new radar will increase the range at which Typhoon pilots can identify potential targets, as well as allowing them to scan a 200-degree field of vision, greater than rival fighters, giving them a tactical advantage.

The addition of the radar will take Typhoon's capabilities ahead of other fourth-generation fighters such as France's Rafale and Sweden's Gripen, making it more attractive to export clients looking to upgrade their air forces.

http://www.telegraph.co.uk/finance/newsbysector/industry/11241622/Typhoon-jets-export-potential-lifted-by-new-E-Scan-radar.html

The RAF has already caught a glimpse of what 5th generation aircraft can do for its Typhoons in training with the F-22s. The experience of training at Langley AFB was quite clear: and to quote the Typhoon pilot: "The situational awareness of the F-22 enhanced our survivability and lethality."

And this pilot saw a future where the hard points on the Typhoon can evolve over time in terms of what it carries to support an initial fifth generation insertion fleet.

The Impact of the F-35 Fleet

The F-35 is built from the ground up to be a 21st century multi-tasking aircraft.

Second Line of Defense

In the words, of Rear Admiral Manazir, the head of USN Air Warfare:

The F-35 is not an A (Attack) or an E (Electronic Warfare) or an F (Fighter); it is all of those. Earlier we had an F-14, an A-6 and an EA-6B and needed all three to do our job; now one airplane blends those capabilities and we can leverage that as we look at the integration of the other capabilities of the air wing we are developing.

Fifth generation is opening up so many possibilities that how we used to think about our capabilities is changing; how do we wring out the full capabilities of the air wing with the fifth generation as a catalyst for change?

Where it used to be platform-to-platform, we now have inherent in a single weapon system, the capability to fold in all those things that we used to think were single missions, like the fighter mission, like the attack mission, like the electronic warfare mission.

Those missions were given to separate platforms because we didn't have the way to fold them into a single platform. Now we have that capability to do that. So that fundamentally causes us to look at the way in which we do business in the future.

http://www.sldinfo.com/expanding-the-reach-of-the-integrated-strike-group-leveraging-fifth-generation-capabilities/

The F-35 will function as a forward scout, a passive sensor strike force, a forward battle management fleet, and generally operate in ways, which will enable the rest of the strike forces to operate much more effectively.

As the head of the Italian Air Force, Lt. General Preziosa, has put it with regard to the impact of the F-35 on his legacy fleet in an earlier interview:

One way to think about the way ahead is to continue to use 4th generation aircraft in surging mass to more classic airpower situations. One would use the F-35 as the key asset up against the distributed operational settings or for operations in denied air space. Another way to look at it will be to find ways to gain more synergy between the F-35 and the legacy fleet. How can we better utilize our older assets during the process where the F-35 fleet becomes a reality?

Shaping combinations of 4th generation with the F-35s will be a mix and match opportunity in tailoring airpower to the missions ahead.

This is a challenge; but it is a key task within which the F-35s will make the legacy aircraft more effective; and the 4th generation aircraft will add support and strike capabilities to an F-35 enabled air power force.

http://www.sldinfo.com/a-21st-century-approach-to-airpower-the-italian-air-force-and-the-f-35/

He then added that when he was speaking of airpower, he was not simply speaking to the question of an air force.

All of the services are enabled by airpower.

"The Navy is not defined by its ships but by its operational reach and this comes with airpower.

The Army tends to think of airpower in terms of their helicopters, but Afghanistan teaches a different lesson.

Continents are working together; why not the services?"

Working New Concepts of Operations

This puts an innovative challenge in front of the UK and Italian Air Forces – how best to work the relationships with a Eurofighter undergoing multi-mission modernization while the F-35 enables air and sea bases to operate with greater reach by linking up with the global fleet of F-35s?

USMC and USN airpower leaders have both highlighted the importance of the F-35 fleet aspects in enhancing the range of the sea base, and its ability to work more effectively with land-based air assets. With the F-35Bs coming off of the amphibious fleet, the reach of the F-35Bs is enhanced by its integration with allied and joint F-35s sharing data, and decision-making. This is a key enabler for the tiltrotar enabled assault force, which comes off of todays' amphibious ships.

For the British and Italians, the ability of the F-35 to tie in the sea base with land-based operations is an important consideration, as F-35Bs will fly off of the new Queen Elizabeth class carriers, as well as off of the smaller Italian carriers, more akin to the USN amphibious ships. Indeed, British strategic planners are already trying to think through the cross cutting of a new large aircraft carrier with a fifth generation strike capability which can allow aircraft on the seabase to integrate other at sea assets with land based ones.

Eurofighters forward deployed on land bases and operationally integrated with the F-35s can provide a lethal expansion of the strike capability of the overall force as the F-35 prioritizes targets and identifies strike support which the Eurofighters can provide as weapons carriers and launchers.

Shaping such integrated concepts of operations will require technological changes as well as cultural changes. The technical changes will be easier than the cultural ones, for sure. The technical dynamic is already under way in working F-22 relationships with the legacy fleet for the USAF.

As then head of the ACC, General Mike Hostage put it:

I have got the command embarked on a full-court press to get a fourth to fifth, fifth to fourth capability that will need a combat cloud to be fully empowered, but it will then allow us to fundamentally change how the fourth generation platforms fight in addition to the fifth gen.

Without that back and forth communication, machine-to-machine, the fourth gen's going to have to do what they already do, they'll just leverage some of the capability that fifth gen — the SA the fifth gen can provide.

If I can get that machine-to-machine, now the fourth gen platform will begin to realize some of the benefits inherently at the tactical level that the fusion engines of the fifth generation aircraft provide.

http://www.sldinfo.com/training-for-air-combat-general-hostage-focuses-on-the-challenge-of-training-for-the-21st-century-fight/

But there is a cultural shift as well which was highlighted in a dialogue between Secretary Wynne and Lt. Col. "Chip" Berke, the only operational F-22 and F-35 pilot in the world.

The fifth generation pilots are going to have to be trained that firing first is not their core con-ops.

Giving validated targets to other shooters is the 'to be' condition.

This is reversing decades of training and experience where the instinct is to fire first and ask questions later.

With 5th generation aircraft you are setting up the air space for air dominance, and weapons are delivered from assets throughout the managed airspace.

Second Line of Defense

Without the 5th generation aircraft you have to fight your way in and expend significant effort just trying to survive.

With the 5th generation aircraft you are setting up the grid to shape the offensive and defensive force to achieve the results which you seek.

http://www.sldinfo.com/shaping-a-new-pilot-culture-wynne-and-berke-discuss-the-way-ahead-for-airpower/

Evolving Weapons at the Vortex of the Change

Weapons have largely been considered as organic assets in terms of the weapon on which they have been integrated. They are integrated to a particular class of airplanes, or variant of that class, or to a particular type and class of subsurface or surface naval platforms.

Now one is looking at the effect being delivered kinetically and non-kinetically by a strike fleet. Fifth generation aircraft will accelerate an off-boarding shift where weapons can be on very different platforms as long as a target identified, and communicated to the strike asset. Over time, unmanned and manned assets will work the target acquisition and delivery dynamic.

But for now, a core challenge for the British and Italians is how to weaponize effectively their "integrated" Eurofighter and F-35 fleet?

Clearly missiles such as Storm Shadow, Brimstone and Meteor are part of the solution set but as solutions are found, a new phase in the evolution of weapons can be opened up whereby an aircraft like Eurofighter could carry much longer range strike weapons (such as SPEAR 3 destined for F-35), rather than focusing on the air-to-air battle as its primary mission.

In other words, the challenge and opportunity for Eurofighter will be to make a real transition to a more flexible strike role through the missiles it carries and can be directed organically or by the command center, which in the emergence of the F-35 will be distributed, not directed by a hub and spoke system as currently is done with the AWACS as the hub of the combat air operation.

For the F-35, the challenge will be to work through its role as a fleet, in operating forward to not only acquire targets, but to strike first passively, or by other means, and to be able to operate within innovative new C2 arrangements.

As USAF Colonel (Retired) Rob Evans put the challenge:

If warfighters were to apply the same C2 approach used for traditional airpower to the F-35 they would really be missing the point of what the F-35 fleet can bring to the future fight.

In the future, they might task the F-35 fleet to operate in the battlespace and affect targets that they believe are important to support the commander's strategy, but while those advanced fighters are out there, they can collaborate with other forces in the battlespace to support broader objectives.

The F-35 pilot could be given much broader authorities and wields much greater capabilities, so the tasks could be less specific and more broadly defined by mission type orders, based on the commander's intent. He will have the ability to influence the battlespace not just within his specific package, but working with others in the battlespace against broader objectives.

Collaboration is greatly enhanced, and mutual support is driven to entirely new heights.

The F-35 pilot in the future becomes in some ways, an air battle manager, or a Peyton Manning-style quarterback who is really participating in a much more advanced offense, if you will, than did the aircrews of the legacy generation.

And going back to my comment about the convergence of planning and execution, and a warfighter's ability to see and sense in the battlespace … that's only relevant if you take advantage of it, and the F-35 certainly allows warfighters to take advantage of it.

You don't want to have a fifth-generation Air Force, shackled by a third-generation system of command and control.

http://www.sldinfo.com/thinking-airpower-leaders-and-preparing-the-way-for-the-f-35/

Leveraging Weapons Commonalities: The Case of the Meteor Missile

A good example of the potential cross benefit between legacy and fifth generation aircraft involves the impact of the Meteor missile upon those European forces operating both Eurofighter and F-35. With Meteor enabled for Eurofighter and F-35A/Bs, the opportunity for joint stockpiling, joint development and common training for a missile, which can be used on both platforms, is significant.

Working through how Eurofighters will work with F-35s is an important operational challenge for the Italian forces, but clearly having a common weapon in the form of Meteor can provide cost savings and amortization of support and training costs as well.

And the F-35 will be able to find targets for the Eurofighter, much like the USMC F-35s are already doing for the F-18s at Yuma or Beaufort Air Stations. This increases the survivability of both platforms, and gives increased utility and becomes a force-multiplier for Eurofighter in an air operation.

Italy is buying a mixed F-35B and F-35A fleet and it would make a great deal of sense for Italy to work with its partners in Alenia and MBDA to shape a common F-35 approach whereby Meteor can be used on both the A and the B.

Italy has invested significantly in Meteor development and currently manufactures the seeker near Naples. It is clear that cost savings can be obtained from pooling resources for buying, stockpiling and maintaining a common weapons capability for the F-35A, F-35B and Eurofighter.

A key element of any rethink about the future of 21st century airpower is clearly working coalition investments and experiences more effectively in building out common capabilities and shaping greater interoperability for operations. The F-35 provides a unique integrated air combat capability whereby coalitions of joint or allied F-35s can be supported in common.

And linking F-35s with evolving overall joint and coalition combat force will be a key opportunity as well. For Italy and the UK, as both F-35B operators, and Meteor partners, there is a clear opportunity to leverage joint experience and investments as well.

The UK is in a similar position with Italy (Eurofighter and F-35B operators), there is a natural partnership between the two in shaping a common policy with regard to Meteor integration on the F-35 and the residual ability to leverage the advantages from commonality.

Furthermore, this gives both the UK and Italy an increased operational edge and grants both nations a significant capability for coalition operations, which could be leverage to enhance their political influence in those coalition operations.

UK and Italian leadership on Meteor would also act as a catalyst towards other JSF users interested in this capability. It is a case of each country's natural alliances reinforcing the others.

There are also broader industrial benefits worth considering as well. It is clear that the global F-35 enterprise draws upon a global supply chain; what is not fully realized is that next generation weaponization can both benefit from the F-35 global enterprise and empower legacy aircraft at the same time.

With regard to Italy, Meteor's integration on both F-35 and Eurofighter offers the opportunity to improve the overall Italian industrial return across the F-35 program and reinforces the investment plan for the Final Assembly and Check Out (FACO) facility; expanding the FACO's role to include the weapon aspects of sustainment is fully in keeping with the vision for a Regional Support Center as clearly articulated by the Italian Government.

In short, developing new weapons for combat aircraft is clearly a core necessity moving forward. The Eurofighter and F-35 sharing the benefits of a next generation missile like the Meteor can enhance as well ways to ensure that these two aircraft work seamlessly across the battlespace for 21st century operations.

AN UPDATE ON EUROFIGHTER MODERNIZATION: THE PERSPECTIVE OF A FORMER ITALIAN AIR FORCE PILOT

During a visit to Europe in the early Fall of 2015, one of the subjects of interest was the cross cutting modernization of the Eurofighter with the introduction of the F-35. Clearly, the Royal Air Force and the Italian Air Force are key players in this process, but during a visit Munich there was an opportunity to talk with some key Eurofighter personnel as well.

One of those personnel was Raffaele Beltrame who is the Eurofghter Project Test Pilot for Airbus Defence and Space in Germany. Previously, he was a Tornado pilot in the Italian Air Force and clearly understands a key element of the Eurofighter transition, namely, the subsuming of Tornado missions within the Eurofighter for the RAF and the IAF. He has been involved with Eurofighter since the introduction of the plane to the Italian Air Force in 2004.

He highlighted that with the Tornado they could load 2 Paveway GBUs but with Eurofighter they can load 6, and clearly from this standpoint, the aircraft represents an upgrade.

The upgrade process and the evolution of the Eurofighter was discussed by Beltrame, in part, through the demonstration of developments in the cockpit simulator. And the cockpit simulator is tied in with the situation room at the Eurofighter facility in Munich, where scenarios are worked through by the pilot in a virtual operational environment.

Beltrame provided a number of key takeaways from our discussion.

First, the inclusion of the air to ground mission sets in the Eurofighter are progressing well. This was not part of the original 1990s design but modifications of the Eurofighter are allowing for this evolution. The program has implemented a number of aerodynamic improvements to the aircraft which allow for a better execution of both the air to air and air to ground mission sets.

http://www.sldinfo.com/upgrading-and-modernizing-the-eurofighter-aerodynamic-upgrades/

Second, given the ability to hold six air to air missiles along with the air to ground missiles, the pilot can be focused on the air to ground but have available systems to protect himself in the air against intruders.

Third, the organic capabilities of the aircraft are expanding, and with the expansion of capabilities, the effort is to improve the capability of the pilot to manage those expanded tasks. This is being done by enhanced automation, the use of voice commands, and an improved helmet and pilot interface to manage the information more effectively for the targeting task.

Fourth, the Eurofighter is designed to work in a network. The further evolution of the Eurofighter is focused on improving its ability to work in a network,, notably one being reshaped by the introduction of the F-35.

For Beltrame, a major change in air combat was underway, whereby the classical C2 structure makes no sense with the coming of the F-35 and the expanded capability of the Eurofighter to execute tasks. As he put it: "A hierarchy certainly remains; but he who has the best situational awareness should be directing the execution of the missions."

He also saw a clear trend to enhance the ability of the ability to leverage automated systems to can better domain knowledge to make better decisions, and this was clearly part of the evolving air combat capabilities of 21st century forces, which in turn drove demand for a different kind of C2 system as well.

He focused as well on the challenge for air power leaders to command a fleet of F-35s and Eurofighters, which would be capable of mixed mission operations over the spectrum of warfare.

The shift from limited and sequential targeting to dynamic targeting of an interactive fleet would be a major challenge moving forward. In other words, shaping an effective C2 system for a dynamic fleet operating in a fluid battlespace has little in common with the slow motion war which we have experienced over the past 20 years.

THE PERSPECTIVE FROM EUROFIGHTER ON THE TRANSITION

The Eurofighter is a clear player in shaping European and global air forces. It has reached critical mass and will be modernized through its operational life to work with new air assets and to deal with the evolving threat environment.

The program currently has seven customers, 599 committed aircraft orders, 446 deliveries to date, more than 300,000 flying hours with 100,000 employees and more than 400 companies involved in the program. This kind of critical mass provides a solid foundation for the evolution of the program.

The Eurofighter consortium has launched a series of capability enhancements as part of a Capability Roadmap, which is designed to increase the combat effectiveness of the fighter. It has evolved from an air defense aircraft to a multi-mission aircraft, notably with the addition of new weapons to subsume Tornado functions and to incorporate a new AESA radar as well as cockpit and linkage improvements as well. And the Maintenance, Repair and Overhaul (MRO) business also ensures that Eurofighter will continue to be a solid program for the next few decades.

Paul Smith, formerly of the Royal Air Force and now with Eurofighter provided an RAF derived perspective on how to think about the transition. Smith is an experienced pilot with more than 3,000 fast jet flight hours with 600 of those hours flying Typhoon. He worked during his time with the RAF for four years working the Operational Test and Evaluation Program for the RAF. And in the period prior to his retirement he worked for Air Vice Marshal Gary Waterfall when he was at the Typhoon Force Headquarters.

At Eurofighter, Paul Smith works on the modernization program, notably with regard coordinating customer input into cockpit design.

Question: Clearly, as you are looking at Eurofighter modernization, notably for the British and Italian customers, there is a clear focus on working Eurofighter with F-35.

How are you approaching that dynamic?

Paul Smith: If you look at both of their future planned force structures, then their combat mass both in terms of number of aircraft platforms and individual aircraft weapon loadout will be Typhoon. Three-quarters of the RAF will be Typhoon going forward into the 30s and 40s and, and somewhere between, around 100 or 50 or so F-35s.

They will be complimentary, with the aircraft contributing related but different capabilities. And it's important that they are absolutely networked.

When considering modernization, one can start with the basic character of the aircraft, with a strong, light airframe with significant thrust to weight ratio. This allows the aircraft to carry a significant weapons load out at Mach 1.5. The kinematics, and the sensor integration in the aircraft have allowed the aircraft to evolve from its initial air defense and air dominance role to a multi-mission role. The aircraft delivers a good integrated picture to the pilot in an effective and simple manner to guide his actions.

It is a different type of sensor integration from the F-35, but we are upgrading our sensors over time, and are clearly doing so with direct relevance to working changes in the cockpit and are also upgrading our helmet mounted display to further enhance pilot decision making.

Question: How would you describe the approach to enhanced air-to-ground attack in the aircraft which is important to the RAF and IAF in subsuming Tornado functions?

Paul Smith: With new sensors and new weapons, we are expanding the weapons envelope to support a broader variety of missions. We are carrying flexible weapon loads to enable us to maintain our air-to-air functions while adding ground attack weapons. We have 6 dedicated AAM stations and currently can simultaneously carry up to 6 PGMs of 500, 1000 or 2000lb class.

The weapons load-out for such an integrated mission by 2018 will include 4 Paveway IVs, 6 Brimstone 2s, 6 AAMs, with a 27 mm Mauser and two 1000L fuel tanks and one Laser Designator Pod or LDP. This will be further augmented by the integration of SDB II and the introduction of the SPEAR next generation precision surface attack missile.

And with the ability to carry Storm Shadow or Taurus, the Eurofighter can provide for a deep strike capability as well with 2 stand-off missiles and 8 air-to air missiles along with a 27 mm Mauser and 3000L conformal fuel tanks and one Laser Designator Pod or LDP.

With a heavy strike load, your primary focus is not air-to-air but of course you need to be prepared to fight your way out if needed. It is not unknown that the air sweep, which precedes a ground attack, may not have removed the entire threat, so having the ability and weapons to fight your way out when needed is useful.

And the broad notion is really air-to-surface not just air to ground, for we are shaping a modernization strategy for maritime attack as well with both SPEAR and Marte-ER missiles integration work in progress.

Question: The engine for the aircraft is well known to be one of its key capabilities. How does engine performance play into the modernization strategy?

Paul Smith: The engine-airframe combination underpins every aspect of fighter weapon system performance. In my experience of flying Tornado operationally, we struggled for aircraft performance when carrying a full

weapon load; the excess thrust means this is never an issue with Typhoon and the engine is virtually indestructible!

There are no scheduled maintenance intervals for the engine; it has a sophisticated Engine Health Monitoring System (EHMS) that uses sensors to inform maintainers of when and what tasks need to be performed. Experience across the whole in-service engine fleet is that the average engine time 'on wing' before initial maintenance is over 1100 hours – indeed, some of the RAF's aircraft have flown more than 1500 hrs without the EHMS flagging up the need for maintenance.

As I noted before, the plane has a very good thrust to weight ratio. For the engine only, it is over 9:1, giving an aircraft thrust:weight ratio of approximately 1.15:1. This is enhanced as well by the low weight and large wings of the aircraft, with a resultant low wing loading. It is a very strong wing with about 70% carbon fiber composites as the baseline material.

Question: With regard to the sensors, a major shift is from your current radar which is maximized for its air to air role to an AESA radar designed to give you a different range and variety of threats and targets.

How would you describe the change?

Paul Smith: The new Captor-E radar allows for greater capability to see and operate within the battlespace. It provides for flexible task management with multifunctional performance and simultaneous modes for air to air and air to surface. It provides an electronic attack capability, which complements our current EW capability on the aircraft as well as ESM, or electronic support measures as well.

The new radar will be able to leverage very effectively the new Meteor missile with its two-way data link to expand the capability of the aircraft to operate against adversary aircraft at a distance and in complex combat situations. The situational awareness delivered by the fusion of Captor and other sensors in combination with the larger no escape zone of the Meteor should give Typhoon a significant combat advantage.

Question: Part of the modernization program is the enhancement of the infrared airborne tracking equipment as well.

How will this program integrate with the aircraft as a combat system?

Paul Smith: PIRATE or passive infrared airborne tracking equipment is designed to enhance our situational awareness and to provide for a passive multi-function track-while scan sensor. It is designed to provide for longer-range detection and enhanced capability to track multiple threats, particularly those with a low RCS.

It will allow us to reshape our combat tactics as well in dealing with adversaries, notably when we add the Meteor missile to the aircraft as well.

Question: In effect, you are addressing Typhoon modernization, missile modernization and evolving sensor integration, including the pods, which you will add, to provide for evolving multi-mission capability.

Is it fair to say then that you are focused then on cross-cutting modernization efforts to enhance its role in the 21st century combat space?

Paul Smith: That is a good way to put it. And the way we are modernizing the aircraft in a way that will make it a very good asset to work the F-35s going forward. And as we go forward we are looking at various data link enhancements, which further enable the air, combat force.

It is a journey but one going in the right way for our customers. It is about gaining and maintaining information superiority and then leveraging that with the appropriate weapons and means to provide for combat superiority.

The way I would put it is that Eurofighter is an inherently living fighter. The platform has longevity in terms of its airframe, power plant, cockpit, avionics and autopilot. It is well positioned for weapons integration and leveraging externally mounted sensors. The airplane is capable of mature sensor fusion and we are focused on evolving the sensor management capability of the airplane as well.

Put in other terms, we are focused on obsolescence management and sustainment adaptation.

And looking forward we are looking to enhance data link bandwidth, ways to further reduce the pilot's workload through expanded automation of functions, where we become more of a "hybrid" air platform.

And in your interview with Air Marshal (retired) Geoff Brown, he highlighted the potential role of the Super Hornet as a UAV/UCAV wingman. We certainly are looking at this role as well.

http://www.sldinfo.com/looking-back-and-looking-forward-in-21st-century-warfare-air-marshal-retired-geoff-brown-looks-at-the-evolution-of-airpower/