

The A380 will enter service in small numbers, and the consequences of this will few options for each type of technical support for operators. Some types of support will have to be sourced long distance. Some options for the various types of technical support that will be available are examined.

Preparing technical support for the A380

The introduction into service of the A380 in 2007 will certainly be historic for the industry, but it will place fresh demands on airport infrastructure and providers of technical support. The A380 will face the same issues that the 747 faced in the early 1970s, with a limited number of aircraft being operated by just a few airlines.

A380 operation

The A380 has been ordered by 16 customers and will be deployed on the world's trunk routes. Demand for technical support will be limited because the fleet will be small. With the A380's operation being concentrated at the world's busiest airports, the provision of technical services will have to be provided by specialists or original equipment manufacturers (OEMs), at least until the global fleet has grown to several hundred aircraft.

Singapore Airlines' (SIA) will operate the A380 to London, so support for different types of eventuality must be considered. Acquiring some technical support may not be problematic at London's Heathrow or Gatwick airports, since Virgin Atlantic has also ordered the aircraft. The number operated by Virgin Atlantic will be comparatively small, however, so it will not be economic to supply all types of support.

The A380 will also be operated to many other airports where it will be less common. This could make supplying certain types of support more difficult. In some situations an operator may have to source emergency technical support from long distances.

Categories of support

There are three key categories of support to consider for all aircraft types, including the A380.

The first is engineering support and aircraft technical management. This includes the supply of all technical and engineering manuals, aircraft systems and engine health monitoring, reliability monitoring, and maintenance planning, and the monitoring of all airworthiness directives and service bulletins.

The second category is maintenance, which comprises several sub-categories, including: line and ramp maintenance; line maintenance control; base/hangar maintenance; component repair and overhaul; and engine repair and overhaul.

The third group is logistical support, which includes the supply and management of spare parts and line replaceable units (LRUs), and also the provisioning of spare engines.

Other issues that must be taken into consideration are field service support for aircraft-on-ground (AOG) situations, and the supply of technical teams and tooling when major repairs or component changes are required.

Engineering support

The many elements of engineering support and technical aircraft management are a special consideration for small start-up airlines with a limited technical department. So far, all A380 customers are large carriers with large in-house engineering departments that already perform all kinds of aircraft technical management and engineering support activities for all other types of aircraft. Providing these services for the A380 should be possible at no extra burden to their existing operations.

One element of aircraft technical management that is unique to the A380 relates to the supply of all types of technical and maintenance manuals, including: the aircraft maintenance manual (AMM); the troubleshooting manual; the fault isolation manual (FIM);

the illustrated parts catalogue (IPC); and the minimum equipment list (MEL). These were traditionally supplied in printed format to airlines by the original equipment manufacturers (OEMs), and had to be managed and kept up to date by a team of dedicated engineers.

All types of manual for the A380 can be supplied electronically, as can the aircraft's entire component and part configuration. Airbus has also developed AIRMAN to assist with analysing and dealing with fault messages, in-service systems failures and technical defects on the A320 family and A330 and A340. Fault messages can be relayed to the ground for analysis by mechanics in an airline's maintenance operations control department. It is also possible for pilots to analyse fault messages and interpret them on the flightdeck, using a laptop, so that preparations for dealing with the problems can be made while the aircraft is still in flight.

AIRMAN analyses fault codes produced by the aircraft's centralised fault display system, and uses electronic versions of the FIM, MEL and troubleshooting manual to analyse these codes. Once the messages have been analysed, the line mechanics can decide whether it is necessary to clear the defect when the aircraft lands, or if it can be deferred for clearance at a later time.

AIRMAN software is constantly being updated, and the new version 9.0 will coincide with the entry into service of the A380. One new feature will be an e-logbook, which will allow pilot reports (PIREPs) to be made electronically and transmitted to AIRMAN. PIREPS are a record of technical faults recorded by pilots and have traditionally been made manually on hand-written technical logs at the end of each flight. AIRMAN will now record and transmit PIREPS electronically, and then correlate them with fault messages sent from the

aircraft's on-board maintenance computer.

AIRMAN has an on-line link with AIRN@V, Airbus's system for providing technical documentation electronically. Airlines can personalise and revise documents using ADOC manager. AIRN@V will allow maintenance control and line mechanics to find the appropriate solution in the shortest possible time. Airbus also has AIRPL@N to assist in maintenance planning.

Maintenance planning

Another two main elements of aircraft technical management are maintenance planning and engine health monitoring. Maintenance planning will revolve around the A380's maintenance planning document (MPD), the intervals between checks, the accumulated hours and time on-wing of systems components, and the aircraft's accumulated flight hours (FH) and flight cycles (FC). It will also consider the aircraft's list of outstanding technical defects and reliability. Again, monitoring aircraft utilisation and maintenance planning is already performed by the engineering departments of the A380's customers for other aircraft types in their fleet.

The A380's maintenance programme will be based on an A check with an interval of 750FH, a C check with an

interval of 24 months and heavy checks every six and 12 years. Like all other Airbus types, the A380 will have a base check system of a cycle of eight base checks, with the fourth and eighth checks in the cycle (the IL and D checks) being heavy checks that include structural inspections.

The heavy checks with intervals of six and 12 years are likely to coincide with the fourth and eighth C checks, meaning that the average actual interval between C checks will be about 18 months. With the first aircraft going into operation in 2007, the first IL check will be performed in 2012-2013, and the first D check in 2017-2018. The number of heavy checks being performed each year will be similar to the number of aircraft delivered annually for the first 10 or 11 years of production. The implications are that the heavy check market will remain limited to 20-25 per year.

Engine management

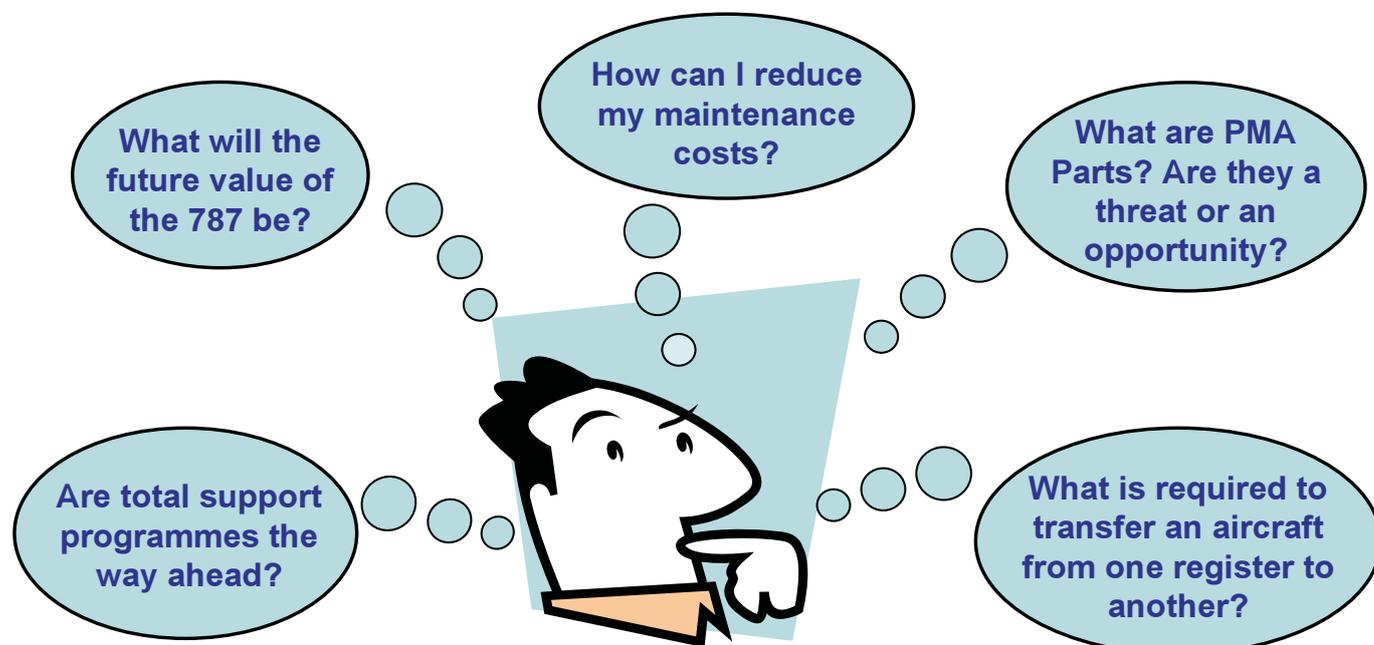
The A380 is powered by the Rolls-Royce (RR) Trent 900 and the Engine Alliance (EA) GP7200. Both engines are expected to have first run scheduled removal intervals of at least 14,000 engine flight hours (EFH). Given that most aircraft will accumulate 4,500FH per year, the first scheduled shop visits will not be expected until 2010-2011.

The number of engine removals will be small at first, but will increase after another two years.

While it will be at least four or five years before engines begin to be removed regularly for scheduled maintenance, engines will still have to be monitored, and unscheduled visits for both light and heavy removals will still occur. There are likely to be few engine facilities available.

RR offers its total care package to customers, and virtually all Trent 900s ordered for the A380 will be managed under this. Total care includes the provisioning of engine maintenance, as well as engine health monitoring, engine maintenance management and spare engine provisioning. Typical contracts are for 10 to 15 years, although in some cases they can be for a 25-year term.

As part of its total care packages for the Trent 900, RR will offer its 'Quick' product, which is an advanced predictive maintenance tool. This will transmit engine performance data on a real-time basis to Rolls-Royce's wholly-owned subsidiary DS&S, which runs its engine monitoring system, 'Alert'. This device will provide a real-time engine condition and health monitoring service for all Trent 900 customers, and allows engines to be proactively removed as their condition deteriorates. This service is expected to reduce unplanned removals by about 50%.



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RR will also provide an engine maintenance management plan as part of its total care package. Customers will pay RR on a flat power-by-the-hour (PBH) rate for all elements of total care, so the onus is on RR to build engines in the shop for optimum life. RR will also have an operations room or maintenance control centre to monitor Trent 900 engines remotely for all customers.

EA has won orders to supply the GP7200 for 68 of the A380s on order from four customers. EA is a joint-venture between Pratt & Whitney (PW) and General Electric (GE).

Bruce Hughes, president of Engine Alliance, explains that the A380 has good on-board engine health monitoring capability itself, which means that engine data can be downloaded from the aircraft. "These data can be downloaded into a ground station database for use by the airline and support providers. EA will provide engine health management and monitoring services to its customers under an agreement with the customers," explains Hughes. The actual technical tasks will be assigned to Pratt & Whitney Engine Services (PWES) and General Electric Engine Services (GEES).

Engine maintenance

Engine repair and overhaul will be limited to a few facilities. RR has won orders from the majority of A380 customers, which include SIA, Qantas, Malaysian Airline System, Lufthansa, China Southern, Etihad, Virgin Atlantic and ILFC. UPS and Thai have not yet made an engine selection.

RR has formed a joint venture with one of its customers, Lufthansa Technik, to perform engine maintenance. The new

facility, N3 Engine Overhaul Services, will be based at Erfurt, Germany. Engine health monitoring for the Trent 900 and GP7200 can be provided by Lufthansa Technik, but the new facility will only be able to offer maintenance for the Trent 900.

As well as engine health monitoring, engine management, and engine repair and overhaul, Rolls-Royce's total care packages also include LRU provisioning services and spare engine support. Besides N3 at Erfurt, the other shop capable of supporting the Trent 900 will be SAESL, RR's joint venture with SIA at Singapore.

The number of aircraft ordered with Trent 900 engines also means that there is a limited market for spare engine provisioning. RR will provide six spare engines, located globally, for spare provisioning. These will be in position to cover for emergency unscheduled removals and to avoid AOG situations. These six engines are being provided in addition to the regular spares that are provided to cover for scheduled removals and shop visits. Regular spares can be leased or bought from Rolls-Royce Partners Finance (RRPF), or accessed via part of the total care package. Purchased engines can then be sold to an independent engine lessor and leased back.

In addition to engine maintenance and spare engine provisioning, RR will also provide AOG support for technical problems and situations relating to engines. A Trent 900 can be loaded onto a 747 freighter through its side cargo door. This AOG support is part of RR's line support for 'on-wing care' of engines, and will be offered through new support centres at Frankfurt and Singapore.

EA will offer PBH services through

Airbus has improved its AIRMAN product to receive both automated messages from the A380's on-board maintenance computer and from the e-technical log. AIRMAN will correlate these as the first step to automating the analysis of technical defects.

PWES and GEES. GEES's shop in Wales, UK is the designated overhaul shop for EA. "Here the engine will be split into its main modules, and the PW modules will go to PWES, and the GE modules will go to GEES. The engine will then be re-assembled and tested at the Wales shop," explains Hughes. "We also have a reciprocal agreement with Air France Industries, which will carry out certain component repairs that they specialise in. This will be the situation while the number of engines remains small, but PW and Air France Industries will bring in additional shops as the number of engines increases."

Besides EA, Air France Industries will provide engine health monitoring services. "This will be provided together with engine repair and overhaul as a total support package," says Alain Brun, business development engine directorate at Air France Industries. "We will work together with EA to help develop our repair capability in-house, including parts and accessories repairs. We will also provide on-wing support for EA and its customers. We will eventually become part of the repair network being set up by EA."

Spare GP7200 engines will be sold by EA to its customers, but EA will also make a lease pool available to provide engines on short-term lease. "We do not have plans yet to make engines available on long-term leases," says Hughes. "AOG and emergency support will come through GE's and PW's emergency desks."

Line maintenance

The nature of A380 operations will be long-haul services between the world's major airports. Aircraft are likely to accumulate in the region of 4,500FH and about 500-550FC annually. The aircraft will have pre-flight or transit checks and daily checks in its line and ramp maintenance schedule. Daily checks will be performed both at operators' home bases and at outstations, and a minority of line checks will be pre-flight or transit checks.

As with the 747 in the early 1970s, some A380 operators will co-operate in providing technical support. Lufthansa Technik is in the process of setting up a four-bay hangar at Frankfurt for A380 line maintenance and C checks. This will

The A380's first heavy check is not due until 2011/2012, and then the number of checks generated each year will only be 20-25. The limited potential market implies there will only be a need for one or two suppliers.

be able to handle a fleet of 15 aircraft by 2012-2014. Lufthansa Technik will provide line maintenance as a global service, and may offer this in conjunction with other A380 operators.

Lufthansa Technik will also use its maintenance control centre at Frankfurt, where it already monitors aircraft for 30 of its customers under its total technical support (TTS) contracts.

Air France Industries will also offer all kinds of maintenance support services for the A380. "This will include line maintenance to C checks," says Herve Page, A380 project manager at Air France Industries. "We are building a new hangar at Charles De Gaulle (CDG) Airport, which will open at the end of 2007. Our first aircraft is due for delivery in February 2008 and we expect to perform our first C check in September 2010."

Like Lufthansa Technik, Air France Industries will provide maintenance control services from the start from its centre at CDG airport.

LRUs & rotables

In parallel with line and ramp maintenance, A380 operators also have to consider the provisioning of LRU inventories, and the repair and management of LRUs and rotables. Air France Industries and Lufthansa Technik have formed a joint venture called Spairliners to supply LRUs and rotables. The main warehouse of components will be kept at CDG airport, and airlines with small fleets in the Asia Pacific are being targeted for these services.

"The intention is that with the Air France and Lufthansa fleets of 25 aircraft, combined with customer fleets, we will be able to achieve the scale effect that is required to keep the cost of supplying and managing these components low," explains Page. "Spairliners will be able to offer more than 900 different part numbers to customers. We will offer airlines a pooling service whereby they have their home base stock of rotables and access to a pool. Required parts will be accessed from the pool, and unserviceable parts returned to it after repair."

In addition to LRUs, A380 operators also have to consider the repair of heavy components. These include wheels and brakes, landing gear, thrust reversers and



the auxiliary power unit (APU).

Most A380 customers have their own wheel and brake shops, and so can manage the repair of these units themselves. The landing gear, supplied by Goodrich will have an overhaul interval of about 10 years. Given the time until the first gear removals are due, and the small number of overhauls that will occur each year, the OEM is likely to be the only supplier of repair services for this component.

Each aircraft will have four thrust reversers, but the fact that the market is split between two engine types means that there will be a limited number of annual repairs. Moreover, thrust reversers have long on-wing intervals in the region of 6,000-8,000FC, and so in the region of 50,000FH. This implies that the first shop visits will not come due until about 2016, and so it is not yet under consideration. Like landing gears, the repair and overhaul of thrust reversers is likely to be left to the OEMs.

The A380's APU is a derivative of the PW100 used on the 747-400. Health monitoring and repair services can be provided by the major maintenance support providers, such as Lufthansa Technik and Air France Industries if required by customers.

Base maintenance

As described, the first heavy check will not come due on the A380 until 2011/2012. Air France Industries and Lufthansa Technik are two providers of hangar capacity for the A380, although Page points out that they will not be able to offer strip-and-paint facilities. "Painting facility requirements are different from maintenance hangars, so

painting will have to be provided as a specialist service. We will, however, be able to provide interior refurbishment at our CDG facility," says Page.

Lufthansa Technik stresses that its new facility at Frankfurt will be capable of line maintenance, and A and C checks. It has not yet made a decision on offering heavy checks, since the first D check on the A380 will be on SIA's aircraft in 2017/2018. Lufthansa's own aircraft is not due its first IL check until 2015, so it has time to consider the size of the market. Given Emirates' order for 43 aircraft, Dubai is the likely location for A380 heavy maintenance facilities.

Field services

While many of the scheduled events of base checks, engine shop visits, and heavy component overhauls are several years away, unscheduled events can occur at any time. Field services for AOG events therefore need to be available.

RR will have spare engines available and new on-wing care centre at Frankfurt and Singapore. EA will provide field services through PW, PWES, GE and GEES. Air France Industries also plans to offer on-wing support for the GP7200. It also plans to offer long-term contracts that could include field services and spare engines.

Lufthansa Technik already provides AOG services as part of its TTS contracts, and will do the same for the A38. It will also provide ad-hoc field and AOG services.

Spairliners will provide field services 365 a year and on-site assistance for rotatable and component-related problems, in addition to the provisioning and pooling services that it plans to offer. **AC**