

The market for used serviceable material (USM) offers independent companies a channel to provide cost-effective, life-limited components to operators of fleets approaching retirement. This has in turn optimised and prolonged the service life of these aircraft families. A series of considerations regarding the global USM market is provided.

# The market for used heavy & system components, avionics

Used serviceable material (USM) and time-continued material are parts derived from scrapped or parted-out aircraft. Operators with ageing fleets that are near to retirement, can use USM to exchange parts in a fleet and subsequently avoid costly repairs and shop visits (SVs) or the purchase of new rotatable components.

The global passenger-configured fleet is moving from ageing and modern aircraft families, to new-generation builds that are starting to enter service. While ageing and retiring fleets include the 737 Classic (737CL), 757, 767, A330 and A340 among others, modern fleets include early A320neos (current engine option), the 737NG (next generation), E-Jets and later build 777 aircraft. Last, new-generation families include the A350, A320neo (new engine option), 787, C-Series and 737MAX families.

“The USM market has grown to \$4.5 billion, and is supporting the \$67 billion maintenance, repair and overhaul (MRO) market,” says Carl Glover, vice president parts supply at AAR. “Average fleet lives are 25 years. The use of USM is now viewed as an industry norm.”

USM activity for an aircraft type is generally triggered when the first aircraft serial numbers (S/Ns) start to reach retirement age. These aircraft are then broken down into harvestable parts, which can provide economic and life-prolonging options for operators looking to maximise the longevity of a maturing fleet. Known as aircraft teardown, this has become a burgeoning business in the past decade.

The aftermarket has also changed during this period, however. Original equipment manufacturers (OEMs) have

become more involved in the MRO of new-generation aircraft, so fewer truly independent options to provide competitive solutions for ageing aircraft can flourish in the market. This shift in dynamics has happened mainly since OEM total care, full coverage power-by-the-hour (PBH) contracts were introduced for operators (see *How do total care engine maintenance contracts affect the remarketing of aircraft?*, *Aircraft Commerce*, August/September 2017, page 6).

The lines between aircraft sale, lease, and aftermarket are therefore becoming blurred. It has been covered extensively that OEM alignment is now essential for MRO participants looking to build business cases for new-generation aircraft maintenance. Aircraft teardown, however, has allowed independent companies to offer alternative solutions as a fleet ages, because it allows them access to parts that up to a certain point have been controlled by the OEM. Some OEM total care contracts are now offering OEM-controlled USM, however.

Glover says that all operational fleet types can use USM as a source of spares. “Typically, the USM market uptake is for fleets that are operating in their post-warranty periods,” he explains. “That being said, operators use the USM market to benefit through initial provisioning tasks and additional stock carriage requirements, where they have not outsourced inventory carriage.”

“The use of USM becomes especially relevant when component availability is an issue,” adds Glover. “This can be due to a lack of OEM support, or the USM costing less than, or the same as, the repair and overhaul charges for a part.”

Ultimately, the value of USM depends on supply versus demand. If a fleet has imploded beyond a certain point as a result of a cascade of retirements within a few years, then the excessive availability of USM components made available from these retirements will affect the value. This is especially the case if the amount of USM available is of a comparable size to the remaining fleet. In addition, operators of the remaining fleet are likely only to require part-lived items, such as life-limited parts (LLPs), heavy components such as engines or auxiliary power units (APUs), or systems. Such operators will seek the cheapest compliant components available, with only a handful of years or about 5,000 flight cycles (FC) remaining. Factory-new items are not required.

Today, there is a pool of aircraft teardown specialists, supplying USM as a result of part-out activity. These include Universal Asset Management (UAM), Aersale, GA Telesis, Avtrade, Touchdown, AAR, AJWalter and AerFin.

## Aircraft teardown

The three key areas that prove profitable in aircraft teardown, and are therefore the key focus of teardown providers appraising aircraft candidates, are the engines, heavy and system airframe components, and avionics. Engines generally account for most of an aircraft’s asset value as the aircraft ages.

“The typical model for aircraft values had a large percentage of the residual economic value attached to the engines, APU, thrust reversers, and landing gear alongside the avionics,” says Glover. “This model has changed in a few aircraft types where the lack of a secondary



market for the engines has undermined their residual values. This has also occurred at the higher component levels of avionics as new technologies and obsolescence erode economic residuals.”

The profit to be gained from aircraft teardown depends on the demand for, and value placed, on each part harvested. Some items will be in higher demand than others, either because they are expensive to repair, or it is preferable to buy a time-continued item rather than overhaul the existing component. The use of USM therefore has to make economic or logistical sense for the operator.

AerFin is a component solutions provider offering asset management, engine teardown and technical support. Earlier this year it dismantled two 737-800s to extract USM for customers, most commonly via a PBH agreement. It has also recently acquired a fleet of E-170s, for the purposes of lease and eventual teardown and parts distribution. “We classify heavy components as being landing gear (comprising three parts), the APU (one part) and nacelles (10 Parts),” says Nick Filce, director of asset sales & MRO at AerFin.

“Depending on the aircraft type and age, we harvest 600-1,000 parts, including heavy components, engine components, systems and avionics.”

“The value of heavy components varies, but loosely based on serviceable values the APU, landing gear and nacelles represent about \$2.2 million of value,” says Richard Jowett, vice president purchasing and programmes at AerFin. “While it is very much subject to condition, type, and life remaining on the

engines, as much as two-thirds of the teardown value is in the engines, and one-third is in the airframe components.

AJWalter is a teardown specialist for 737NG, A320, 777 aircraft and A330s with Trent engines.

Over the past five years, AJWalter has parted out the following: 17 A320s, nine 737 Classic (737CL), five 737 next-generation aircraft (737NGs), two A340-500s, two A330s, two 767s and one 757. These numbers reflect the availability and demand for parts within that fleet. While the A320 and 737NG are maturing, most of the in-service fleet is not yet near retirement. The 737CL is ageing and a large portion of the fleet has retired, but low fuel prices mean that some operators have delayed phasing it out of their fleets.

“USM is not a factor in determining aircraft being torn down by the seller,” says Filce. “The economics and availability of aircraft have an impact on who the buyer is, however. Delays in delivery of some new-generation aircraft have seen demand for older aircraft and the extension of leases. The lower price of oil is a determining factor as well, since this makes older aircraft more economic to operate.”

Operators use USM to make MRO more cost-effective, by avoiding costly repairs that are uneconomic for a fleet approaching retirement. “Teardown does not limit repair activity; rather it actually keeps it going,” says Conrad Vandersluis, senior vice president strategic material & asset management at AJWalter. “Parts still need to go through the MRO shop after teardown, and may still need repairs performed. Aircraft teardown and the

757 USM is of substantial interest, due to the types’ active secondary freighter market. About two thirds of 757 freighters in operation today have been converted from passenger-configured aircraft (Flight Global FleetsAnalyzer).

development of USM within the market therefore maintains a healthy MRO environment as fleets mature.”

AJWalter harvests 750-1,000 part numbers (P/Ns) from the average aircraft teardown, depending on the type. “These include line replaceable units (LRUs), nacelle components, and flight control systems, which represent some of the most valuable airframe components,” explains Vandersluis. “We estimate that 60% of teardown value is tied up in the engines, 30% in airframe rotatables and components, and 10% in airframe and structural parts. This varies depending on the age and residual value of the engines however. The value of USM for an aircraft is directly related to the number of part-outs that have taken place versus the number of the type in operation, so it will fluctuate according to the number of part-outs. USM marketability depends on fleet renewal activity.”

According to Vandersluis, certain 737CL material is currently in short supply as the retirement rate has slowed, so components are holding good value in relation to the demand for such material. “If there is a sudden rise in teardown activity for the Classics however, then USM providers will try to claw value from the components quickly, which causes a value drop,” he continues. 737NG engine components are another area seeing high demand activity.

“Meanwhile demand has dropped significantly for older generation CRT cockpit displays on the Airbus aircraft because they have been replaced on newer generation with LCD/LED displays, with upgrades proving costly,” says Vandersluis. “Operators therefore want to replace these with new model aircraft for operational costs that comply with upcoming regulatory changes.”

The 757 is an aircraft family whose service life has been prolonged by an active secondary and freighter market. Today, there remain more than 660 in operation. 375 are passenger-configured aircraft, whereas 285 are freighters.

About two-thirds of 757 freighters in operation today have been converted from passenger-configured fleets, according to Global Fleets Analyzer, totalling about 200 aircraft. Naturally, 757 retirements and teardown are of significant interest to freighter conversion

companies, which require economic material solutions when re-configuring aircraft. The compliance of the aircraft undergoing conversion is also a significant factor.

Precision Aircraft Solutions specialises in conversion and modification programmes across the 757 and A321 families. According to Brian McCarthy, vice president of sales at Precision Aircraft Solutions, 757 part-out began to happen routinely among the oldest models, circa 1990. “When assessing 757 candidates for part-out or conversion, we typically see core market values of \$600,000-700,000 for the engines and \$500,000-600,000 for the hull remaining (airframe and heavy components),” says McCarthy. “This assumes that the engines are ready for a shop visit (SV), and that the aircraft has reasonably compliant avionics with RNP1 features and or EASA Standards. If the aircraft has life remaining on the gears or APU as well as any retrofit avionics and add-ons, such as Pegasus FMCS, updated MMRs and MCDUs, the hull value can increase to \$700,000.” According to McCarthy, traceability of the landing Gear and APU, and LLPs is also key to any value bump.

### Old & new generation models

It is generally acknowledged that

commonality between the variants or series within an aircraft family helps to maintain the value of those components that are homogenous across the fleet. This is because there is more than one channel for the USM to be implemented, so demand remains high for longer, since components do not depend on just one ageing aircraft. This relationship can be bolstered further to some degree, when taking into account old- and new-generation versions of a single type. A key example is the 737.

But at what stage does the USM market for heavy and system components implode, and part-out start to become less profitable or over-supplied? “The determining factor is commonality across aircraft type and number of aircraft in service,” states Filce. “The 737NG has more than 3,000 in service, plus the remaining 737CLs in operation with life of more than 10 years still have a substantial demand for USM. Meanwhile Fokker 70s and 100s are a retiring fleet that has been replaced by CRJs, E-Jets and Q400s, and will therefore have less demand for USM.”

This rule does not apply to heavy components, such as the APU and landing gear. Manufacturer serial number (MSN) can become a greater factor influencing the market demand for USM of these components. “Heavy

components cannot be interchanged between classic and new-generation variants,” adds Jowett. “Older versions of new-generation fleets can also suffer from declining markets, such as those with pre-enhanced gears installed versus those with enhanced equipment. MSN and age can therefore have an impact on value and subsequently demand.”

In fact old- and new-generation models of the same base aircraft type, share very little commonality in the large, profitable USM. “The commonality between CL and NG models is just over 20%,” continues Jowett. “The remaining parts on the 737NG are not common to the 737CL, so they do not affect CL demand, as they are not interchangeable. In this instance, it is down to how many 737CL aircraft are still operating.”

### Repair vs replace

As an aircraft matures, components that become beyond economic repair (BER) will be replaced, because it is no longer financially viable to repair them. This varies depending on their value. The point at which a component will become BER therefore depends on: the cost of replacing it; the level of specialist repair requirement to repair the item; and the downtime required to perform this repair.

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will be replaced, not repaired,” adds Vandersluis. “As the fleet ages, specific type components reduce in value. For example, the 737NG inlet cowl cost \$400,000 10 years ago, while its USM value is now closer to \$150,000 in a like-for-like condition.

“Given that the repair cost can vary from \$60,000 to \$100,000, the BER argument to replace rather than repair is getting stronger,” continues Vandersluis. “USM demand for the 737NG inlet cowl is therefore likely to increase, which may bolster the value temporarily. It is this relationship between repair versus replacement of a part, and the supply versus demand for the USM, that can cause USM values to fluctuate for heavy components in a type’s maturing years.”

The stage at which replacement is better than repair therefore ultimately comes down to cost. “An aircraft may be parted out at the end of a lease, or be cannibalised by an owner to feed the rest of their fleet, depending on market value. When USM availability reaches the stage where its value drops, this will also cause the repair versus replace decision to move towards ‘replace,’” adds Vandersluis.

“When the Fair Market Value (FMV) for a SERV/OHC component becomes close to the cost of a heavy repair, the uptake of USM increases to displace costly repairs,” says Glover. “This may

also be accelerated by lack of capacity in the repair network, meaning operators accept USM in lieu of a potential BER or costly turnaround time for a repair.

“The repair and maintenance strategy of the customer(s) also influences the replacement of parts through USM. Controlling inventory quality and repair schemes is key when discussing USM support with customers,” adds Glover.


APUs, nacelles and flight controls are high-value items which tend to become the first USM candidates, according to Vandersluis. “This still depends on repair costs and damage though. Smaller operators will be among the first to exchange components rather than invest in costly repairs by sourcing USM, though this is not without problems during a lease agreement,” he adds. For instance, return-to-lessor conditions may request the aircraft’s APU to be less than 20,000 flight hours (FH) since new. If damage is found during a routine lease-return check, the operator may look at the USM options available to replace it. “Although it may be possible to source an APU for less than the cost of a repair, if the USM component has high FH, it may not be compliant with the lessors’ conditions,” adds Vandersluis.

Replacement of some P/Ns can also be impacted either by the OEM or by regulatory authorities. “Airworthiness

can drive demand for USM material,” adds Glover, “where incorporation of ADs/SBs requires operators to comply in a short period of time.” This was seen recently on a couple of maturing engine types where inspections were required on Fan Blades (CFM56-7) and some considerations on HPT inspections on the V2500 engine variants. This pushed the demand for USM as operators looked for whole engines or compliant USM for fleet sustainment.

Filce explains that, due to their value and complexity, heavy components tend to have a long life because they are refurbished to near-new condition each time. “If parts that are deemed as rotables and repairables fail, you look to repair them before considering replacement. You would only replace them if they were BER. If the airline needs to replace a part and has nothing in stock, it will look to its PBH provider or source exchange, where the fee is a fraction of the outright value, and overall including repair or an unserviceable (u/s) part is still cheaper than buying,” he says.

“The 737CL saw the gap closing between repair and replacement costs,” says Jowett. “This drove parts to be scrapped and in turn made some more expensive due to lack of supply. Another issue is that if an airline has the history of a part, they may want to keep it within



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their control rather than scrap and replace it. The cost and availability of piece parts affects decisions as well.”

### Airworthiness directives

ADs and the aircraft’s modification (mod) status can affect USM demand, since performance or safety improvements drive removals. “While aircraft S/Ns generally impact values within a fleet, this varies depending on the aircraft’s mod status,” says Filce. “ADs will always be a factor since they may make a part obsolete, either because it is so old that there are no more parts available to replace it, or it is an airworthiness requirement to meet safety regimes.” Vandersluis refers to TCAS systems, whose residual value can disappear overnight as a result of an AD that mandates a complete change of the system, or a software update that renders the model uneconomic for operators.

“When an AD is released for a specific fleet or variant, airlines review it and determine the implications of support on a programme,” continues Filce. “This may include support from the OEM of the part affected by the AD, the airline’s PBH provider, or they may source exchange units to use as seed units to carry out the programme of modifications by the given deadline.”

Vandersluis adds that when ADs are released for mature fleets, USM that complies with ADs/SBs still tends to be cheaper than new, so operators are likely to use USM.

### Heavy components market

In terms of regional activity, demand

for USM will be highest wherever the ageing fleets are operating. “Demand per region will vary depending on the aircraft types being operated there,” says Jowett. Vandersluis says that the US still sees a large demand for 757 and 767 USM, due to freighter and commercial activity. Aircraft conversion activity will also drive demand for USM in an ageing fleet.

“Airlines will turn to the USM market if they need to deal with aircraft on the ground (AOG) or ops-critical parts, although component exchanges are more likely rather than outright purchases.”

Primarily, airlines, MROs and third-party contract providers, such as AJWalter, will purchase USM. AJW invests in USM to bolster its PBH inventory pool and Parts Sales & Support offering. “Shipping is a key consideration when positioning some heavy components, such as flight control systems,” says Vandersluis.

“MROs buy many of the heavy components since they need to offer airlines seed units, while overhauling such major assets,” says Filce. “Airlines tend not to stock heavy components and will try to pass the burden of stock to MROs.

“Depending on fleet size, however, there is still an appetite for inventory,” continues Filce. “Airlines tend not to buy as much as in previous decades, because they recognise that high inventory costs are needed to support a fleet, and often it is never enough to prevent incurring additional costs and despatch reliability issues. This explains the growth of PBH support contacts, where the airline avoids the risk of holding assets that depreciate over time, or of disposing of those assets when migrating to a new aircraft product. The demand for USM is partly

*Aircraft families with classic and new-generation series, such as the 737, optimise the demand for USM as and when parts can be shared between the types. For example, both the 737 Classic and the 737NG have the same anti-ice system installed.*

being driven by PBH providers seeking lower acquisition costs on material sourced from torn down aircraft.”

Regional standards need to be considered, however. “For instance, the US requires a strict trace history on all USM parts,” explains Vandersluis. “Operator and MRO shop standards usually stipulate that parts must come from a Part 121 or 129 operator, otherwise the Quality department will not permit the use of that part. Also, any repairs that the part has undergone must have been performed by an approved vendor. In addition, some airlines might have a policy of only buying new or OEM-sourced parts. This is especially the case for new-generation aircraft, and total care contract fleets.”

### Landing gear, engines, APUs

Engines account for most of an aircraft’s value as it ages, so they are a significant focus of teardown companies, while the high value of LLPs and turbomachinery parts make engine USM the most required in MRO.

Most engines can power more than one aircraft family, thereby increasing the demand for part-out material. Meanwhile, others can be upgraded to power more than one series within an aircraft family; for example the PW100 engine family powers the ATR 42 and 72.

“Supply and demand in relation to heavy components fluctuates, depending on the age of fleets,” says Jowett. “Landing gears typically need to be overhauled on a 10-year calendar basis, so demand peaks when major fleets hit this milestone.”

“In contrast, as nacelles and APUs tend to be “on condition”, overhaul demand is sporadic because it is based on failure rates,” adds Filce.

The ‘potential’ of a component, part or system, that is, the ability to install a part on more than one aircraft series (or even type), or its degree of commonality, will boost the demand for that USM. “Certain key systems have some fleet commonality, but many need to be modified before being used in an alternative fleet,” says Glover. “Examples are the 331-200 APU on the 767 and 757. The V2500-A5 and CFM56-5B engine variants can also be modified via thrust rating and some quick engine change (QEC) components for



application across the A320 and A321 Series. AAR's Technical Services team work with operators to perform such changes.

"Few modern systems are pure plug-and-play homogenous components (that are common across different fleets), so some re-certification is needed," continues Glover. "Those components that do have multiple applications are also those that are typically more abundant in USM markets as they come from multiple fleet retirements."

The issue facing USM availability of any one fleet in-service, is the point at which the USM loses value. Providers therefore need to manage USM inventory levels against the current demand for that USM, combined with anticipated retirement rates for the fleet. Vandersluis cites the CFM56-5A and V2500-A1 engine variants on the A320, as examples of redundant USM in the current market. "With the fleet of early A320s powered by these engines shrinking, parts specific to these models have little to no value," he explains.

"Engine values are generally worth the core value, plus any flight cycles (FC) remaining and the lives remaining on the LLP stacks," adds McCarthy. "Engines with LLPs that have another SV left in them are most desirable for freighter conversion. When sourcing PW2000

engines we typically look for 3,500-4,500 engine flight cycles (EFC) remaining to 'short build' an engine for cargo."

For the landing gear, the 737 Classic has also seen the USM market deplete significantly, as demand has waned for the component. "The 737CL fleet still in operation has a large percentage of its landing gears now due for overhaul," continues Vandersluis. "Yet due to the age of the fleet, operators only need part-life components that will last until they retire their Classic fleet. Given the volume of available part-lived 737Classic components available in the market, these are cheap to acquire, so landing gears available from teardown today hold little value in the market for this fleet."

## Systems & avionics

System components generally comprise parts relating to hydraulics, pneumatics, and electrical systems on-board the aircraft. These cover anti-ice systems, fuel and bleed air systems among many others, and generally start to fail as they age. System components typically have the lowest degree of commonality between aircraft types.

The architecture behind aircraft systems has dramatically changed in the past decade, with the 787 becoming the first aircraft type to feature primarily

electrical systems. This further removed its commonality from other aircraft types; for example it does not have bleed air. The GENx-1B and Trent 1000 engines that support these electrical systems are designed specifically for the 787 because of this architecture. This therefore means that fuel and electrical system USM for the 787 cannot be used on other fleets, which limits the market for USM to the 787 only. While the 787 was the first type to incorporate a mainly electric system, new-generation aircraft such as the A350 and Bombardier CS100 and CS300 have now followed suit.

"Regarding system USM, components that have a higher BER rate or lack of re-work in the manuals are typically some of the first to enter the USM market," explains Glover. "If a housing re-work causes the unit to go BER, then USM adoption is useful. AAR has seen this with component repairs for hydraulic and pneumatic systems. We have also seen this in mature engine variants where the cost to overhaul, NDT, weld, heat cycle major cases and frames has caused them to go BER, so customers adopt already overhauled USM materials."

"On mature aircraft, some of the USM market sometimes has greater availability than the OEM production channel, so it is a critical alternative for operators and MROs," adds Glover.

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“This drives the longevity of the USM market for major systems that are no longer in production. This has also influenced some key OEMs to add a USM to their service offerings, or partner with USM providers such as AAR in the aftermarket.”

Systems between old- and new-generation aircraft are likely to be different, and therefore not homogenous. “This makes it unlikely that systems harvested from older, mature generations of the aircraft family can be used within younger, new-generation models,” says Vandersluis. “This will affect the demand for USM for these old systems, once the old-generation fleet has depleted.”

While commonality between systems and components on board the 737CL and the 737NG is low, Vandersluis points out that the anti-ice system is the same, so 737CL systems can be used to maintain the maturing 737NG fleet. “This commonality between systems has allowed this particular product to maintain its value well,” he adds. “This should remain the case until the 737NG fleet starts to decrease. The same may also be true for non-common components between the A320CEO and NEO”

Other than hydraulic, pneumatic or electrical systems, Vandersluis highlights the value of in-flight entertainment (IFE) and broadband connectivity systems as products that remain consistently in demand, and therefore useful USM when arising from teardown. “These products are transferrable across the entire global fleet, and are growing in demand due to the rising number of operators using them,” he says.

Regarding avionics, multiple factors affect demand and also profitability.

“Avionics is a key area due to the airworthiness impact on the aircraft. Most parts that have an operational restriction will impact demand, because this can reduce the availability of the aircraft or its operating parameters,” says Jowett.

“TCAS units are product-specific, so as long as they comply with current airworthiness and navigational regulation, they maintain value and demand very well, with the exception of any ADs that render a particular product obsolete” says Vandersluis.

McCarthy highlights the different priorities of the aircraft conversion industry when it comes to aircraft candidates. Two specific areas are aircraft weight, an intangible benefit, and avionics available on-board. “The aircraft itself is not the candidate for conversion today, but rather the avionics it has on board,” he explains. “The value of the hull of a very old-generation aircraft can be as low as \$300,000, but the avionics can account for \$150,000-200,000 of that. Avionics carry a good third of the hull remaining value for older-generation aircraft. High value avionics systems include the flight management computers (FMCs), multi-mode receivers (MMRs), MCDUs and flat panel displays (if installed). These are the key avionics that help qualify a 757 for Future Air Nav System (FANS) operations and we assess this status when appraising conversion candidates.”

McCarthy adds that the reason behind the importance placed on avionics, is the new airworthiness regulations that will apply in the near future. Since the purpose of aircraft conversion is to give aircraft an extended

*The A340 is a retiring fleet of aircraft. This means that demand for the USM is no longer matching the surplus availability of parts. Fleet depletion due to retirements will also cause material obsolescence.*

secondary life, and is not about prolonging the phasing out of a commercial fleet (due to fuel prices or the fleet renewal strategy of an airline), conversion companies need to think over a longer term than teardown specialists

These airworthiness regulations include required navigation performance (RNP) and controller pilot data link communications (CPDLC), and require certain system capabilities to be provided by aircraft in order to operate effectively in various regions. These are part of the future air navigation system (FANS) requirements that are due to come into force in 2020. “The compliance for RNP avionics varies depending on the region in which an aircraft is operating,” explains Ian Gilbert, aerospace consultant at IG Avionics.

RNP-1 compliance is developed for operation in Terminal Areas, while RNP-4 is designed for aircraft operating in remote locations. Gilbert explains that most 15-20 year old legacy aircraft are likely to only possess RNP-10 standard avionics, unless they have been upgraded from factory installation. The difference between each standard relates to the monitoring and alerting capabilities of the systems, for instance when the aircraft deviates from its flight path. In addition, RNP-10 compliant systems were developed to permit 50 miles of lateral and longitudinal separation between aircraft, while RNP-4 allows 30 miles. The upgrades, up to RNP-1, are therefore designed to allow more aircraft to operate within a certain airspace, and while terminals will require a reduced distance between aircraft to account for traffic, remote regions can allow for greater separations. It should also be noted that RNP requirements vary between regulatory authorities.

Avionics systems on freighter candidates need to be compliant, which can lead to significant costs if upgrades or new avionics need to be installed. “While RNP-4 and CPDLC will become requirements in 2020, operational restrictions are already beginning to apply in some areas,” continues McCarthy. “For instance operators cannot fly from Hong Kong to Perth without RNP-4-compliant avionics systems. Older-generation 757-200 freighters without these systems will require \$1.3-1.5M of retrofitted systems to keep operating past 2020. FMCs, for



example, need the storage and RAM capability to support the graphical requirements, so older models will become redundant.

“Moreover, extensive cost and downtime are needed to acquire supplemental type certificates (STCs) and master changes (certifications, design and wiring harnesses) from the aircraft OEMs, and retrofit these flat-panel display systems on older aircraft,” adds McCarthy.

Vandersluis also points out that the architecture in new-generation aircraft has shifted away from the traditional blackbox. This will naturally affect the demand for this equipment in time. “The 787 introduced the concept of electrical architecture, meaning a move towards software-driven systems. This is becoming more prevalent across new types entering development and production,” he continues. “Systems are now becoming more dependent on avionics and software, rather than requiring multiple hardware items.”

## Retirements & secondary markets

There is a difference between an ageing fleet and a retiring fleet. The demand for USM will be at its highest while the fleet matures, and this period

will be at its longest if the fleet remains in production for a long time. Examples include the A320ceo and 737NG. Once most of the fleet has reached retirement age, however, the availability of USM for heavy components will quickly outweigh demand. “The A340-500 and -600 are both prime examples of retiring fleets,” says Vandersluis.

“Clearly the volume of retirements drives the supply of surplus in the market, as does fleet maturity and the level of general inventory in population,” says Glover. “Traditional aircraft such as the 737CL, 747, A320ceo and A340 have all seen a large increase in surplus availability and obsolescence. AAR checks for redundant P/Ns during regular maturing fleet analysis, to assess the USM demand for heavy and system components on each type.

“There is also a glut in certain engine types where there is limited use of USM,” continues Glover. “This may be driven by the ownership structure of the engine, MRO market capacity on certain engine types and the lack of ‘demand pull’ for materials.”

As stated, USM generally undergoes the highest level of demand as the fleet matures, and the first retirements start to occur. This is generally expected to happen after the second or third lease, or as the oldest aircraft in the fleet hit about

25 years of age. By this stage, an aircraft family is expected to have enjoyed a long production life, a stabilised maintenance programme, and an active secondary market. USM is therefore in high demand, as the bulk of the fleet hits maturity after the oldest MSNs.

However, one scenario in which USM could enter the market early, that is, before the 20-25 year mark, is if the aircraft family is not experiencing the active secondary market. This could mean that activity within the fleet does not justify the need for USM. “When teardown providers are looking to part out aircraft or engines, a key factor to be considered is the route to market and expected return from the P/Ns,” says Jowett. “What we are seeing today, is that sometimes when the secondary market is struggling for an aircraft type, a secondary market can be created.”

This follows on from Aerfin’s recent acquisition of 15 E-170s. While primarily these are to be fed into the leasing market, thereby bolstering secondary market activity for the type, some of these will be prime candidates for teardown, and maintaining Aerfin’s USM inventory. Many of the harvestable parts will also be applicable for E-175 and E-190 fleets.

“Early part-outs of a fleet, and the effect on future USM demand, is a topic that OEMs, lessors and operators have



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been discussing for some time,” says Glover. “The lack of a secondary market clearly undermines residual values. The typical model of appraising aircraft and inventories, underpinned by the USM secondary operational markets, needs review. This should also influence the future sustainment and support strategies of the operator, who may want to encourage competition for maintenance and supply of components, engines and aircraft to ensure a secondary market.

“The risk is that some key aircraft or components become limited in their use and ultimate marketability,” adds Glover. “Some of this is being seen now with customised 777, A380 and A330 aircraft.” The costs to re-configure aircraft for its follow-on lease application provides some lessors with options to consider the USM option or re-leasing the aircraft.

The A380, though a comparatively young aircraft family, is one recent example of a type yet to gain any traction in the secondary market. This will obviously affect the supply versus demand relationship for USM in the long run. If aircraft cannot find operators for secondary leases, or those wishing to extend current lease agreements, then the industry could soon see a number undergoing teardown.

## Pooling strategies

Airlines will have different component pooling strategies in accordance with fleet size, global coverage, route network, third party contracts in place, and in-house MRO capability. The logistics behind maintaining a complete inventory of heavy, system and rotatable components

is labour-intensive and financially burdensome for most. Many operators will therefore seek to have agreements in place with spares providers and third party suppliers (see *Spare parts supply chain management, Aircraft Commerce, August/September 2016, page 53*). Such providers include AJWalter and AAR.

AJW is able to offer PBH agreements to airlines. These allow the customer to choose which component(s) it would like the agreement to cover, component MRO management, how or where it would like this stock positioned per individual fleet profiles, and any required logistical considerations such as shipping and customs.

AAR offers inventory support/repair & pooling agreements for operators. “Our Integrated Supply Chain Solutions are typically structured to leverage the use of USM inventories. OEM support solutions aggregate inventory carriage costs, repair spend while increasing asset availability,” explains Glover. AAR has more than 1,600 aircraft under contract, with operators including LCC and mature carriers.

“Component support programmes enhance residual USM demand and also allow providers to integrate with OEMs to aggregate their offerings,” continues Glover. “AAR offers USM in our active Parts Supply business. As fleets mature, operators are looking to capture the economic benefits of our USM levels to support their fleets through sales/leases & exchanges.

“Most of the key component OEMs have entered the USM market with their offerings,” adds Glover. “This clearly impacts new parts sales but it also re-affirms the acceptability of USM to the

*The avionics installed on the earliest 757 L/Ns will not comply with upcoming regulatory requirements such as RNP. In order to avoid operational restriction, costly upgrades and retrofits may be required.*

airline and MRO community.”


## The future

“New technologies such as 3D printing will mature and affect USM,” says Glover. “At present, however, these are focused on non-safety-critical components, such as interiors, rather than profitable USM parts.

“The introduction of the A320neo and 737 Max fleets with the growing backlog will affect the USM market in two ways. First, it will increase the amount of narrowbody retirements feeding the USM market,” adds Glover. “Present fleet retirements of less than 2% will therefore increase.

“Second, there is some commonality on the MAX and neo components with the current fleet, so operators will be able to harvest some component inventories from the current fleet to support new fleet introductions,” continues Glover. “Clearly some of the new technologies on the latest aircraft will push some older component systems into to the USM market or result in their obsolescence entirely. Where this gets interesting is during the fleet transition phase for our customers where we are supporting both older and newer entry into service fleets, we’re managing components throughout the entire life cycle.”

“During the early stages, heavy components for the neo and MAX will be supported by the OEMs, with low demand for USM,” says Jowett. “AerFin is seeing movement towards on-condition components that last longer on the aircraft and require less maintenance. The OEMs will therefore seek to control this market while they are recouping their R&D costs.”

“The industry will soon see a large number of fleet transitions, with the emergence of these new-generation models,” adds Vandersluis. “The question is, what will happen to the aircraft teardown market for the aircraft that these models are replacing? Can they be used in freighter markets, or be transferred to different regions as they become more economic in emerging markets?” - CLD 

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