

Fighter Aircraft Through Life Costs

A Standardised Comparison

Aviation Week Network | Intelligence & Data Services

May 2023

On Behalf Of:



An Introduction to Through Life Costs



Through Life Costs

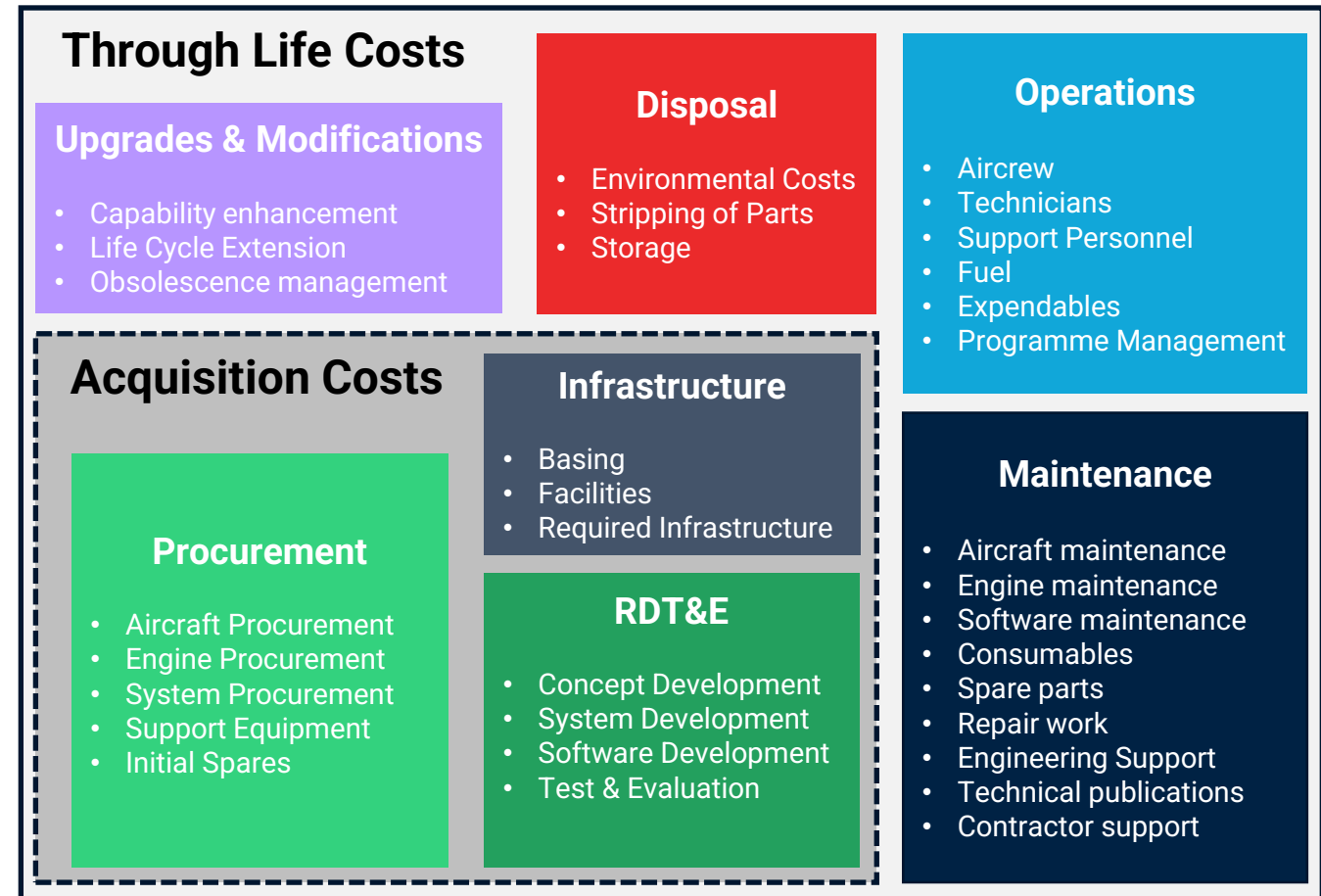
Through life costs encompass the total of ownership associated with the acquisition of specific military assets

As governments and operators strive for additional transparency around the long term financial implications of major defence acquisition decisions the consideration of the through life costs (TLC) associated with specific types of military equipment has become increasingly important.

TLCs encompass the full scope of the costs associated with acquiring, operating, and maintaining an asset over its entire lifespan, from design and development through to retirement and disposal. As such TLCs provide governments and operators with evidence based assessments of the total costs of ownership associated with a specific acquisition decision.

Nevertheless, while the majority of acquisition programmes establish a budget for the initial procurement phase of the project, the adoption of TLC assessments as part of the selection process is far from universal. This can result in longer term implications for affordability and subsequently the viability of a specific capability.

Furthermore the use of TLC estimates is complicated by the lack of a universal approach to their development. The cost elements included within the scope of TLCs, how they are attributed to specific aircraft fleets, and the way in which they are measured and quantified vary significantly from country to country, from operator to operator, and from programme to programme.



Aircraft Life Cycle Phases

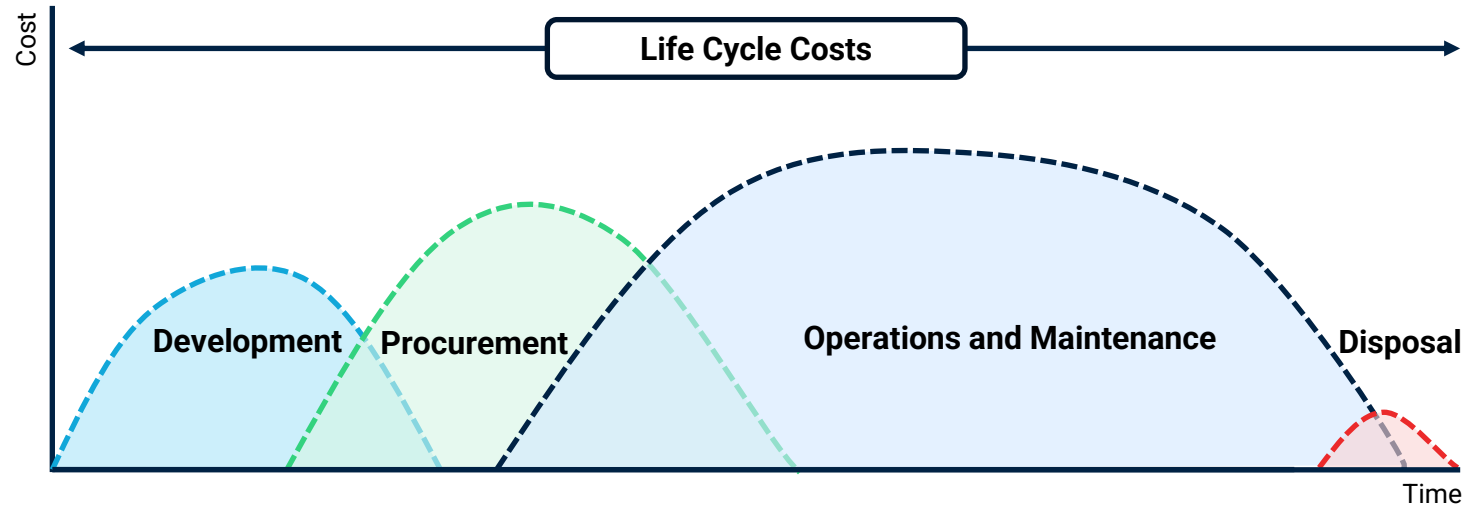
The four core phases of an aircraft's life cycle are development, procurement, operations & maintenance and disposal

The life cycle of an aircraft can broadly be divided into four main cost phases: development (RDT&E), procurement, operations and maintenance (O&M), and disposal. These phases can vary significantly in terms of their length, associated costs, and the individual cost elements included within them. The scale of the costs incurred under each phase can also vary significantly based on factors such as the type of aircraft, operational tempo, and length of service life.

Not all aircraft acquisition programmes include each of these four cost phases. For example the procurement of aircraft 'off-the-shelf' avoids the costs of developing the aircraft shortening the acquisition timeline and generally reducing costs. Similarly individual cost elements within these phases can also be excluded such as where existing infrastructure is sufficient to house the new aircraft.

The majority of global fighter aircraft acquisition programmes – particularly those involving tenders released to industry – begin at the procurement phase, incurring no cost within the RDT&E phase (although elements of aircraft development costs may be amortised within procurement costs by the aircraft OEM).

As such, for international fighter tenders, >98% of costs generally relate to the procurement and operating and support phases of the aircraft's life cycle.



RDT&E	Procurement	O&M	Disposal
Covers the development costs for the aircraft and generally accounts for between 8-12% of total life cycle costs. While the majority of aircraft acquisition programmes exclude this phase OEMs can seek to recoup RDT&E related costs within the procurement phase when making future sales to export customers.	Covers the production costs of the aircraft and the associated equipment required to enable its operation. Represents the most capital intensive phase of an aircraft acquisition and typically accounts for between 25-35% of total life cycle costs. Costs incurred within this phase are generally the most widely publicised	Day-to-day costs of operating the aircraft through the life of the programme including personnel, maintenance, fuel, and associated support. Largest phase in terms of costs, generally accounting for >60% of total costs. Spending generally split into multiple support contracts through the life of the programme	Final phase of expenditure and relatively minor in comparison to other phases as <1% of the total life cycle costs. Can also be avoided through transfer or sale of out of service aircraft to third party customers. Can also include the stripping of retired airframes for spare parts in order to reduce O&S costs and sustain remaining fleet.

Importance of Aircraft Through Life Costs

Through life cost estimates provide greater transparency around the long term costs associated with aircraft acquisition

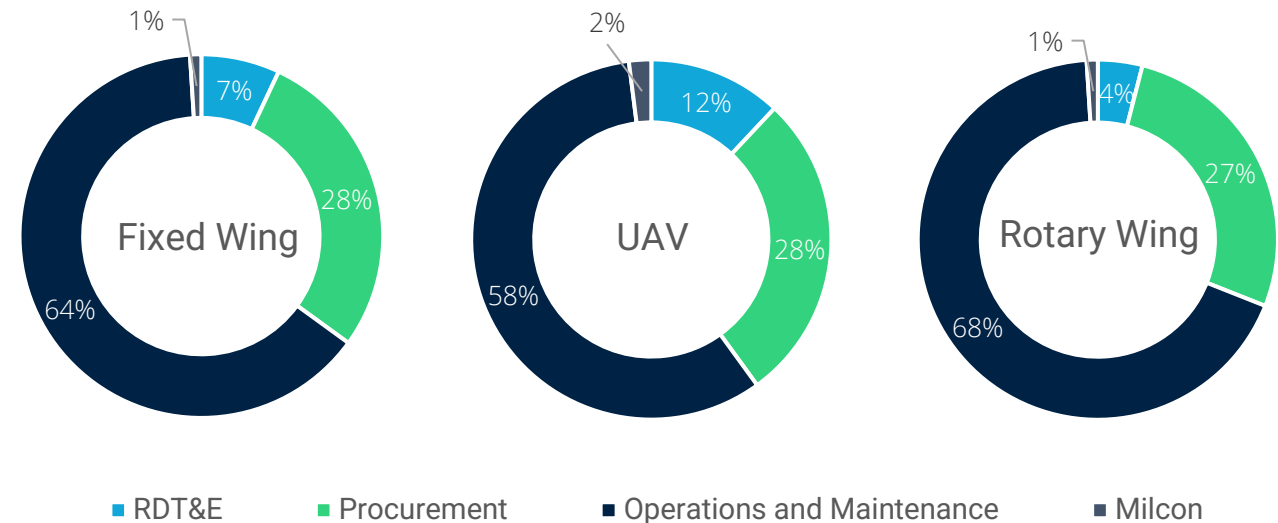
Through Life Cost (TLC) estimates provide governments and operators with a critical means by which to assess the long term affordability of aircraft programmes. They can inform aircraft selection in acquisition projects, aid long term planning around the allocation of resources, and can also be used to monitor costs through the life of a programme.

While the capital outlay associated with an aircraft acquisition is normally well defined, often contractually, and usually represents one of the key selection criteria for a specific platform, total TLCs are generally two to three times higher than these initial costs. U.S. Department of Defense analysis of the cost of major weapon systems throughout their life cycles suggest that more than 60% of military aircraft costs are incurred during the operating and support phase. This compares to around 7% for RDT&E and 28% for procurement.

TLC calculations therefore provide a greater degree of insight into the total cost of ownership associated with a specific aircraft type and can ensure more clarity within acquisition processes and decision making. This will ultimately provide more accuracy around resources requirements and help to avoid budgetary constraints that can emerge in the operating and support phase of the aircraft life cycle.

Despite this, in many cases subsequent through life costs are either excluded from selection criteria, are seen as less critical in deciding acquisition choices, or do not have a well defined scope that enables suppliers to develop accurate and comparable TLC estimates.

Average Breakdown of Major Cost Categories as % of Total Life-Cycle Cost



Extension of Operations and Maintenance Phase

The service life of fighter fleet are lengthening, increasing the importance of the O&M phase within overall TLCs

A key consideration with regards to the importance of TLC calculations is the trend towards longer O&M phases for military aircraft. With this phase generally accounting for more than 60% of overall costs the extension of this phase has significant implications both for the scale of O&M costs and subsequently for overall life cycle costs.

Analysis of fighter aircraft fleets that have been withdrawn from service over the last two decades suggest that the average life cycle of these fleets is gradually increasing. AWN collected data on the entry into service and final retirement dates of 35 fighter aircraft fleets that were withdrawn or are projected to be withdrawn from service between 2005 and 2025.

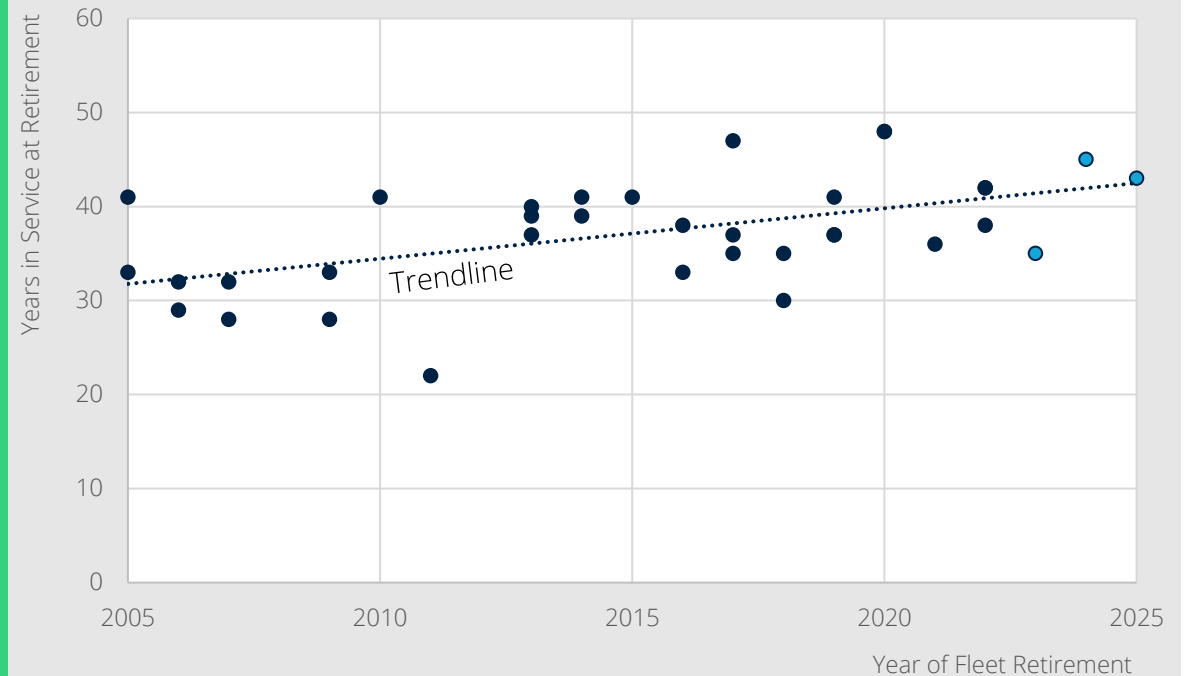
The data suggests that the average number of years between a fighter fleet entering service and leaving service over that period is 37 years. Furthermore the data also suggest that this average fleet service life has continued to gradually extend with retirements between 2005 and 2015 occurring after an average of 34.7 years and retirements between 2015 and 2025 occurring after 39.4 years.

Average Fleet Service Life:

37 years

The expanded capacity for technology insertion, mid-life upgrades, and more recently the planned use of collaborative unmanned aircraft to augment core capabilities means that this trend has the potential to extend further still in the future. As such O&M costs have the potential to become increasingly central to the determination of overall TLCs.

Service Life of Fighter Fleets at Year of Retirement



Note: The above chart plots the number of years in service for 35 fighter aircraft fleets that have been retired over the last 20 years. Years in service is calculated from the first aircraft entering service to the last aircraft leaving service and therefore reflects the service life of the fleet as a whole rather than the age of individual aircraft leaving service.

Through Life Cost Study Aims

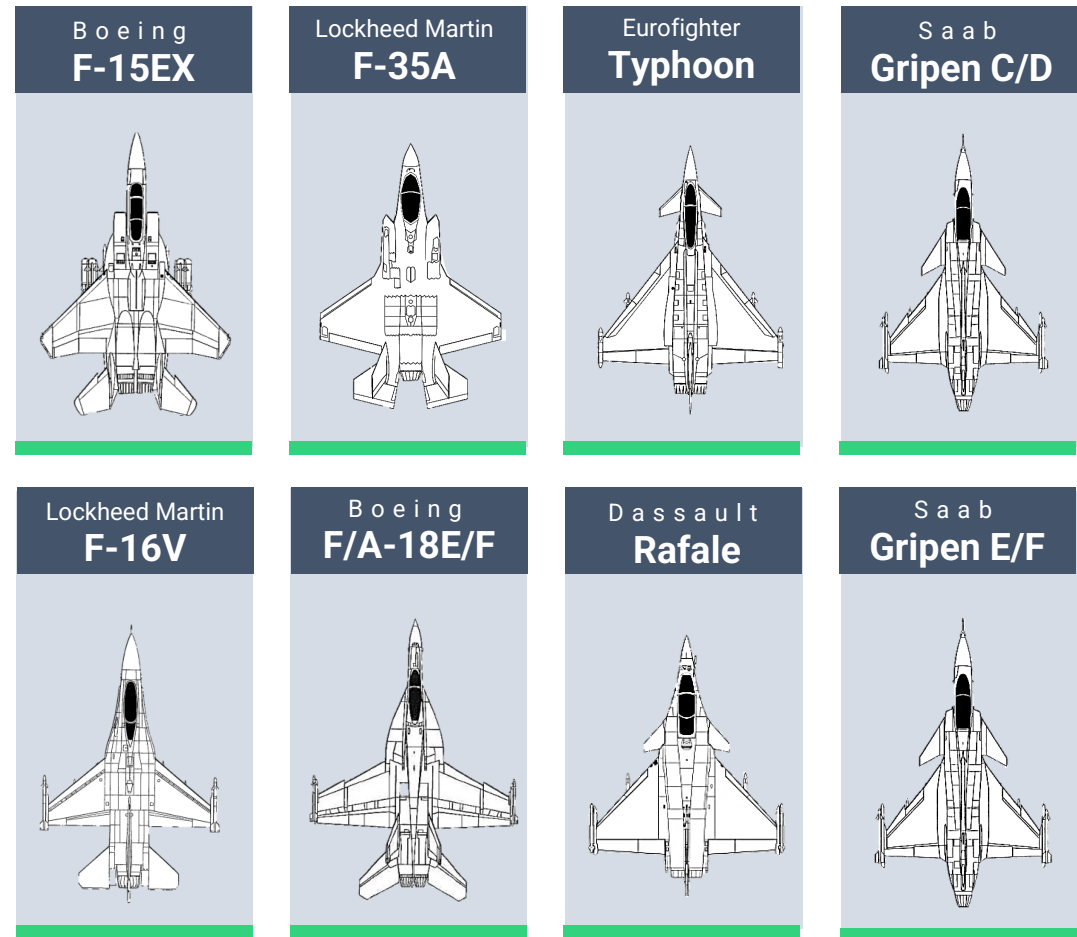
This study aims to provide a standardised Rough Order of Magnitude (ROM) estimate of the through life costs of a range of fighter aircraft currently in production and active in global markets. The aircraft assessed as part of the study are the Boeing F-15EX, Boeing F/A-18E/F, Lockheed Martin F-16V, Lockheed Martin F-35A, Dassault Rafale, Eurofighter Typhoon, Saab Gripen C/D, and Saab Gripen E/F.

Central to this goal of providing a comparative analysis of the TLCs of the aircraft within this study is the adoption of a standardised scope of the cost elements assessed. This scope is focussed upon the assessment of three principal cost categories: Acquisition, Maintenance, and Operations, and utilises a standardised set of sub-component cost elements within these categories (see methodology section).

The study does not represent the totality of the potential cost of ownership of the aircraft assessed and specifically excludes elements that are inherently variable between operators such as associated weapons procurement and through life upgrades. The cost elements included are intended to enable an assessment of the core cost elements which would be broadly applicable to all potential operators and which are specific to the operation of the aircraft.

All data used within this study has been obtained from open sources including government budgetary projections, government spending data, contractual information, financial disclosures, and press releases. The data sources used for these calculations have been identified throughout the relevant pages of the study in order to provide transparency.

This ROM analysis is intended to provide a comparative analysis of the core through life costs associated with the aircraft included within the study based upon available data. It should not be considered a budget-quality costing estimate.

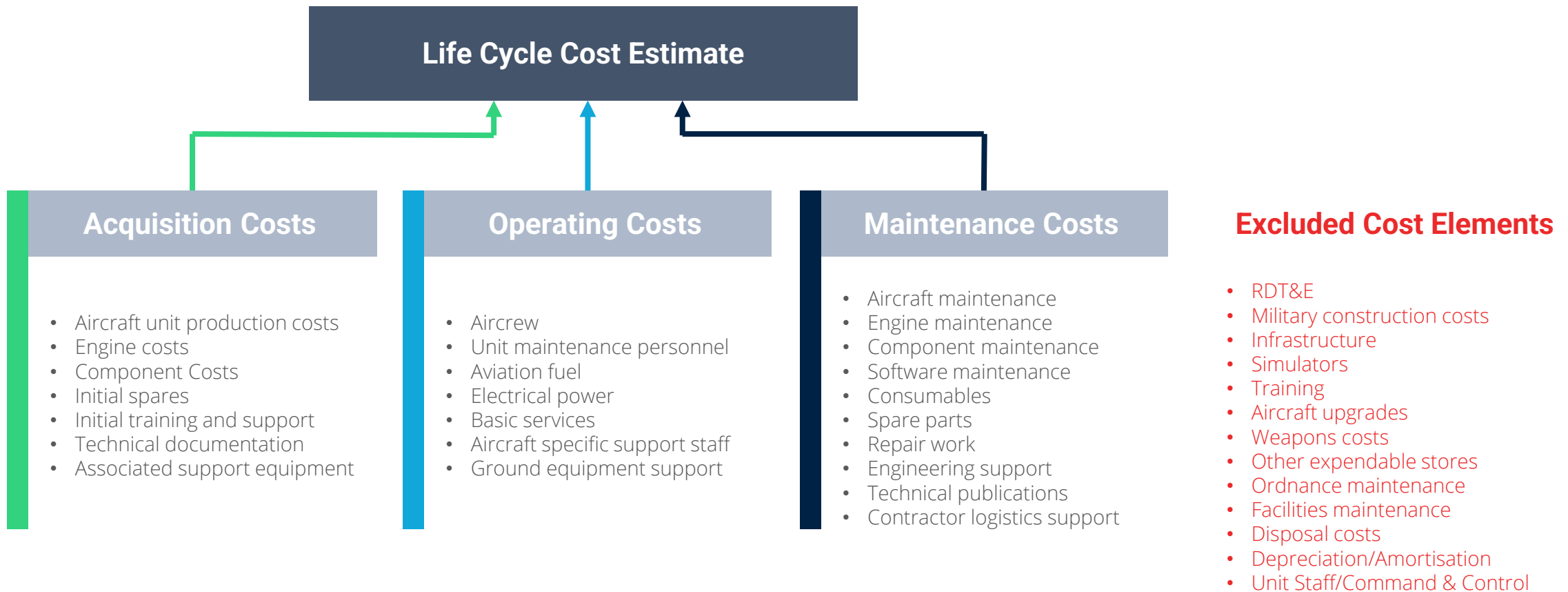


Study Methodology



Cost Elements - Scope

All aircraft specific cost elements that would be incurred by any operator are included within the scope of the study



Theoretical Fleet Baseline Assumptions

Fleet Size

100 aircraft acquired
Based on a feasible notional fighter aircraft acquisition programme and to provide alignment with non-U.S. fleet sizes assessed within this study.

Service Life

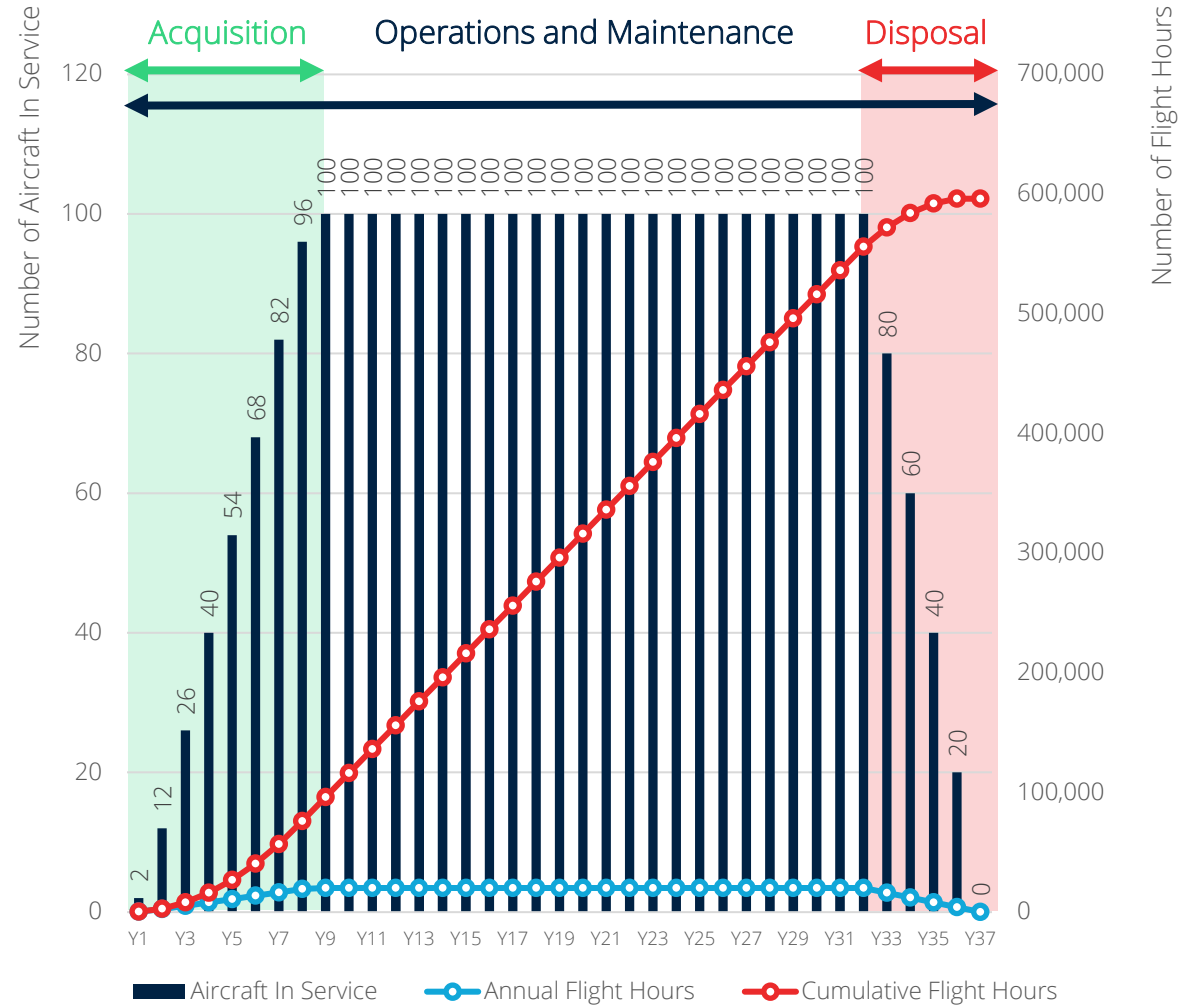
37 years service life for the fleet
Based on the average service life of fighter aircraft fleets withdrawn between 2000 and 2025.

Utilisation

200 flight hours per aircraft per year
Based on average annual flight hours per aircraft flown by the eight fleets used as the basis of this assessment.

Fleet Hours

596,000 flight hours total fleet service life
Based on applying the average annual flight hours to the aircraft fleet size with adjustments for fleet deployment and withdrawal.

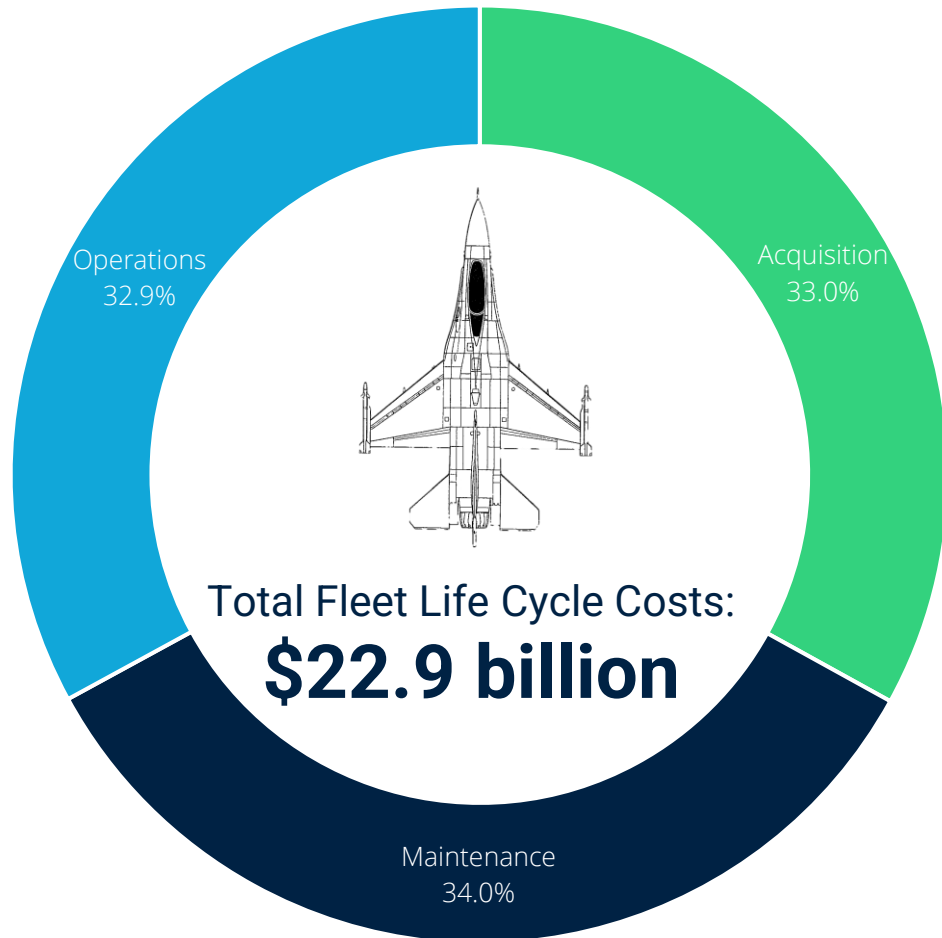


Through Life Cost Estimates





F-16V (Block 70/72) Fighting Falcon

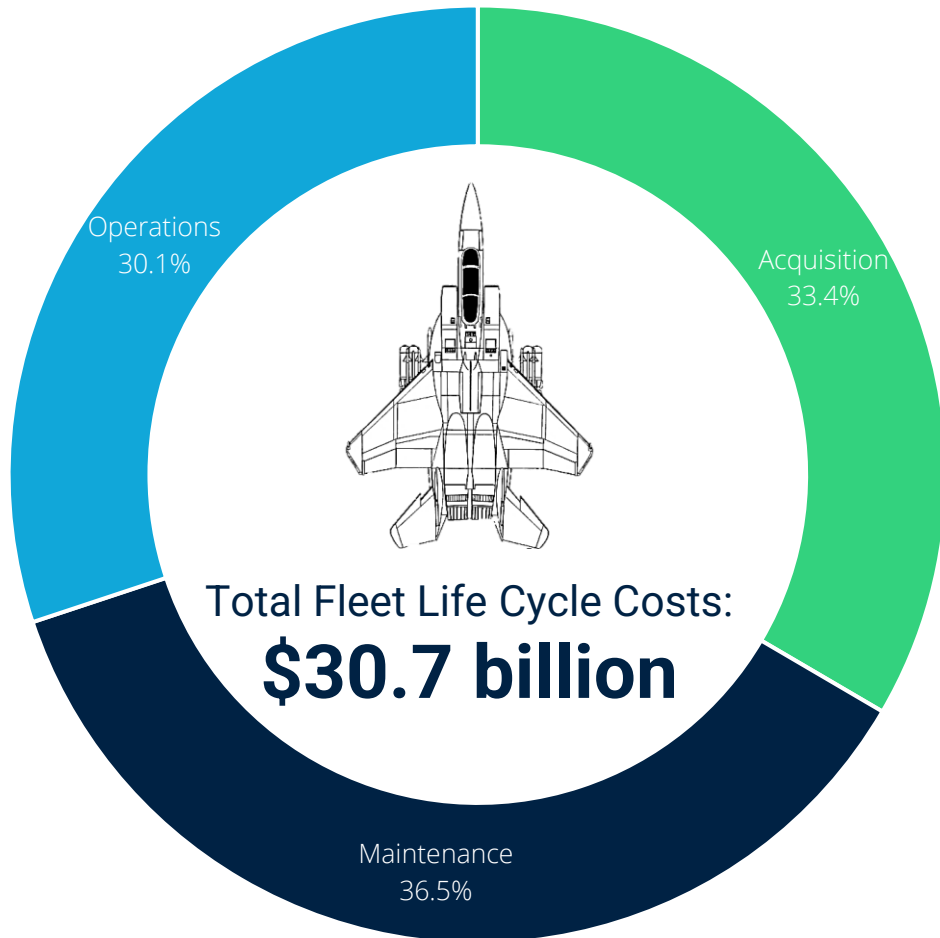


Acquisition	Weapon System Unit Cost:	\$75.5 million
	Fleet Acquisition TLC:	\$7,548 million
Maintenance	Maintenance Cost (\$/FH):	\$13,048
	Fleet Maintenance TLC:	\$7,776 million
Operations	Operations Cost (\$/FH):	\$12,633
	Fleet Operations TLC:	\$7,530 million

Source: U.S. Department of Defense data on U.S. Air Force O&S costs taken from the AFTOC system
 Source: F-16 FMS contract: <https://www.defense.gov/News/Contracts/Contract/Article/2313931/>
 Source: F110-GE-129 contract: <https://www.defense.gov/News/Contracts/Contract/Article/2827649/>



F-15EX Eagle II



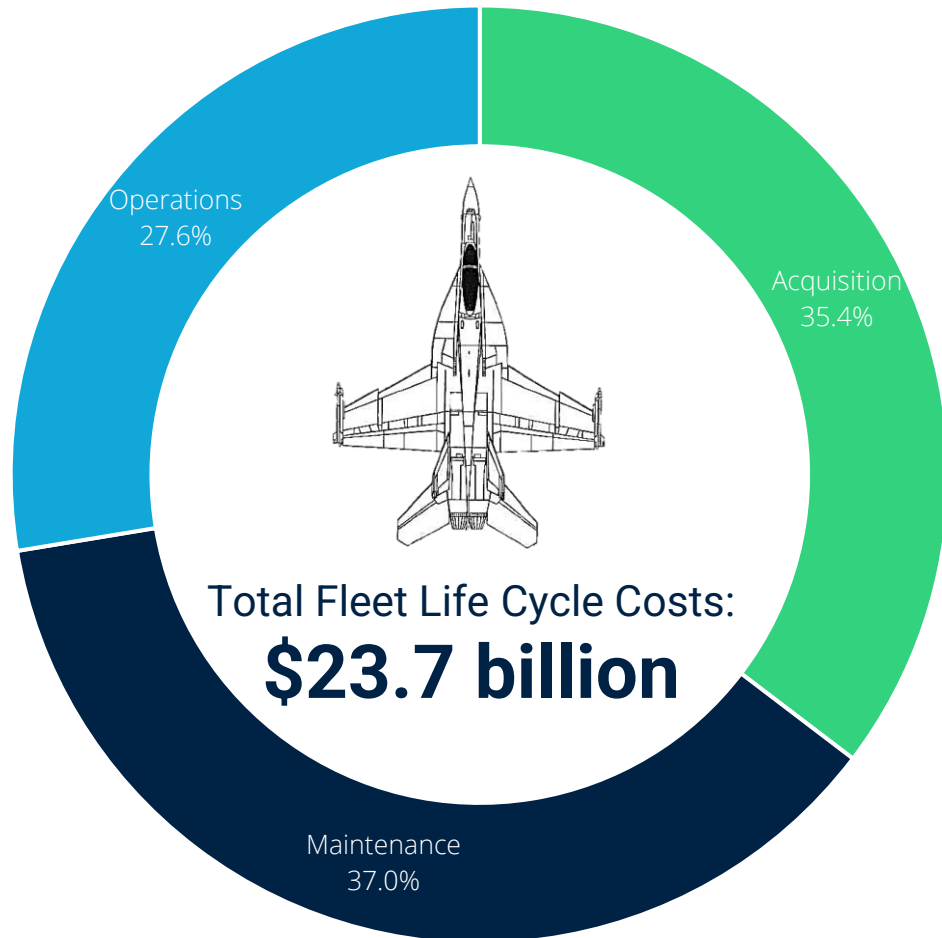
Acquisition	Weapon System Unit Cost:	\$102.7 million
	Fleet Acquisition TLC:	\$10,272 million
Maintenance	Maintenance Cost (\$/FH):	\$18,803
	Fleet Maintenance TLC:	\$11,207 million
Operations	Operations Cost (\$/FH):	\$15,515
	Fleet Operations TLC:	\$9,247 million

Source: U.S. Department of Defense data on U.S. Air Force O&S costs taken from the AFTOC system

Source: F-15EX unit cost: <https://www.saffm.hq.af.mil/Portals/84/documents/EY24/Procurement/EY24%20Air%20Force%20Aircraft%20Procurement%20Vol%20I.pdf?ver=NME%20Up6ZQJkMDUTjzBwtbA%3d%3d>



F/A-18E/F Super Hornet



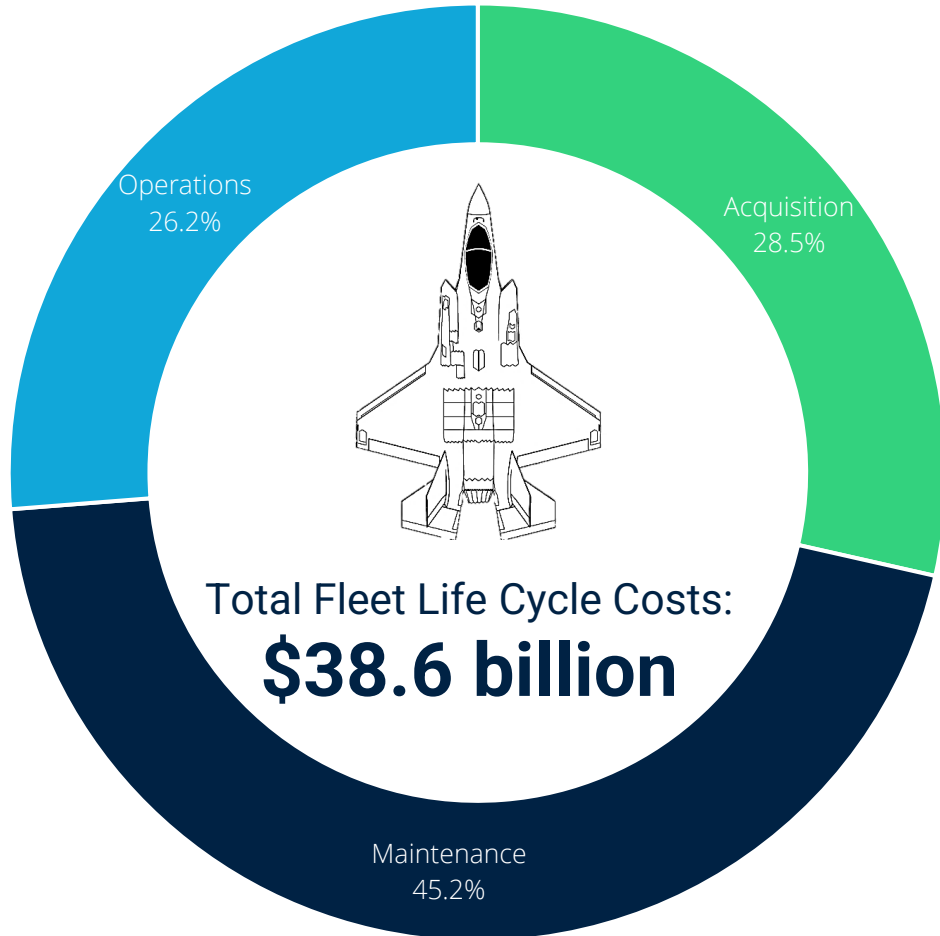
Acquisition	Weapon System Unit Cost:	\$83.9 million
	Fleet Acquisition TLC:	\$8,388 million
Maintenance	Maintenance Cost (\$/FH):	\$14,745
	Fleet Maintenance TLC:	\$8,797 million
Operations	Operations Cost (\$/FH):	\$10,989
	Fleet Operations TLC:	\$6,549 million

Source: U.S. Department of Defense data on U.S. Navy O&S costs taken from the VAMOS system

Source: F-15EX unit cost: <https://www.saffm.hq.af.mil/Portals/84/documents/EY24/Procurement/EY24%20Air%20Force%20Aircraft%20Procurement%20Vol%20I.pdf?ver=NMEUp6ZQJkMDUTjzBwtbA%3d%3d>



F-35A Lightning II



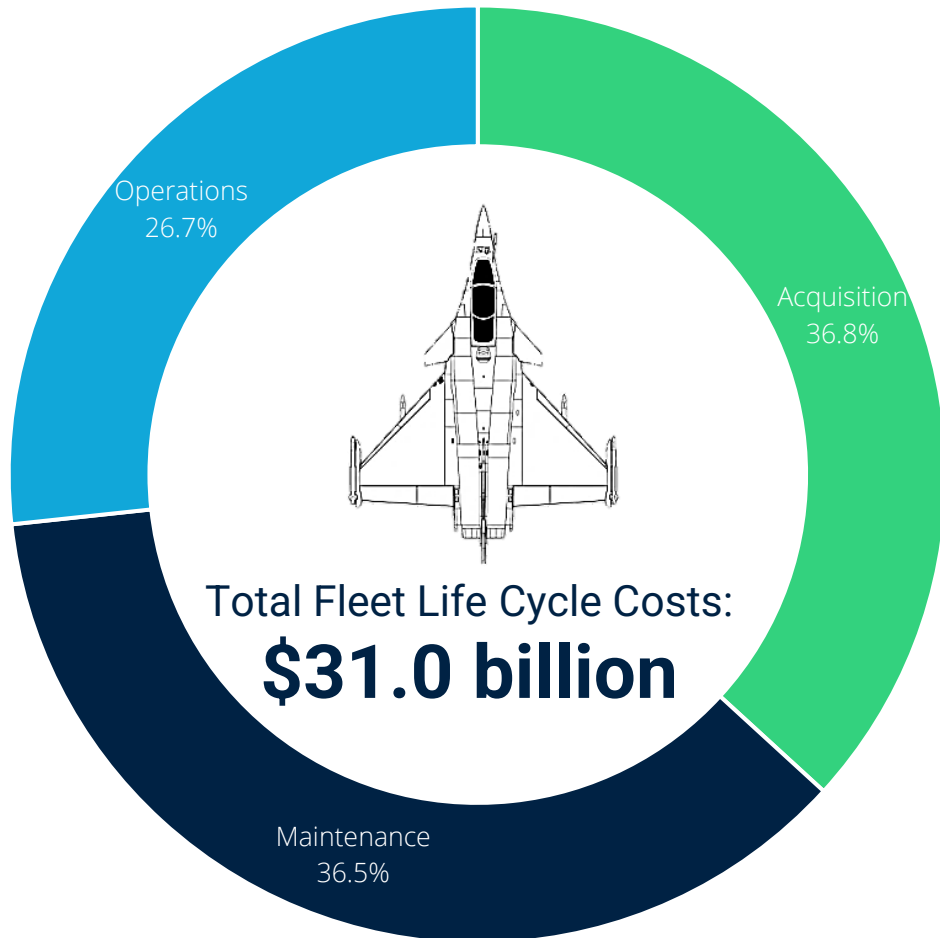
Acquisition	Weapon System Unit Cost:	\$110.2 million
	Fleet Acquisition TLC:	\$11,015 million
Maintenance	Maintenance Cost (\$/FH):	\$29,283
	Fleet Maintenance TLC:	\$17,452 million
Operations	Operations Cost (\$/FH):	\$16,999
	Fleet Operations TLC:	\$10,132 million

Source: U.S. Department of Defense data on U.S. Air Force O&S costs taken from the AFTOC system

Source: F-35A unit cost: <https://www.sajfm.hq.af.mil/Portals/84/documents/FY24/Procurement/FY24%20Air%20Force%20Aircraft%20Procurement%20Vol%20I.pdf?ver=NME%20Up6ZQjKMDUJzBwtbA%3d%3d>



Rafale



Acquisition	Weapon System Unit Cost:	\$108.4 million
	Fleet Acquisition TLC:	\$10,839 million
Maintenance	Maintenance Cost (\$/FH):	\$18,045
	Fleet Maintenance TLC:	\$10,755 million
Operations	Operations Cost (\$/FH):	\$13,193
	Fleet Operations TLC:	\$7,863 million

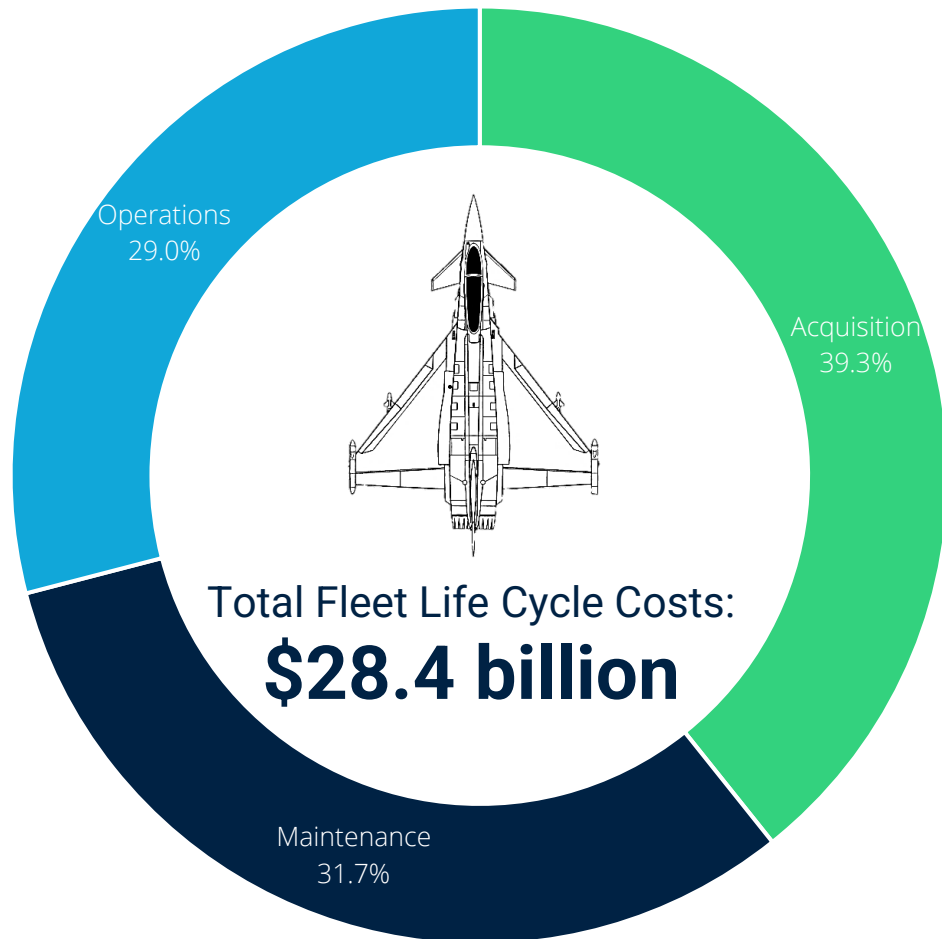
Source: Rafale Unit cost from Indian defence officials: <https://timesofindia.indiatimes.com/india/government-says-rafale-cost-secret-but-had-disclosed-it-in-2016/articleshow/62812165.cms>

Source: Maintenance costs taken from official answers to questions in Assemblée Nationale: <https://www.assemblee-nationale.fr/questions/detail/15/QE/15768>

Source: Operating costs derived from U.S. Air Force and U.S. Navy operating costs taken from AFTOC and VAMOSC systems reflecting actual spend on O&S costs



Typhoon



Acquisition	Weapon System Unit Cost:	\$111.7 million
	Fleet Acquisition TLC:	\$11,165 million
Maintenance	Maintenance Cost (\$/FH):	\$15,112
	Fleet Maintenance TLC:	\$9,007 million
Operations	Operations Cost (\$/FH):	\$13,853
	Fleet Operations TLC:	\$8,257 million

Source: Typhoon unit cost from: <https://www.airbus.com/en/newsroom/press-releases/2022-06-spain-orders-20-eurofighter-jets-under-landmark-contract-to>

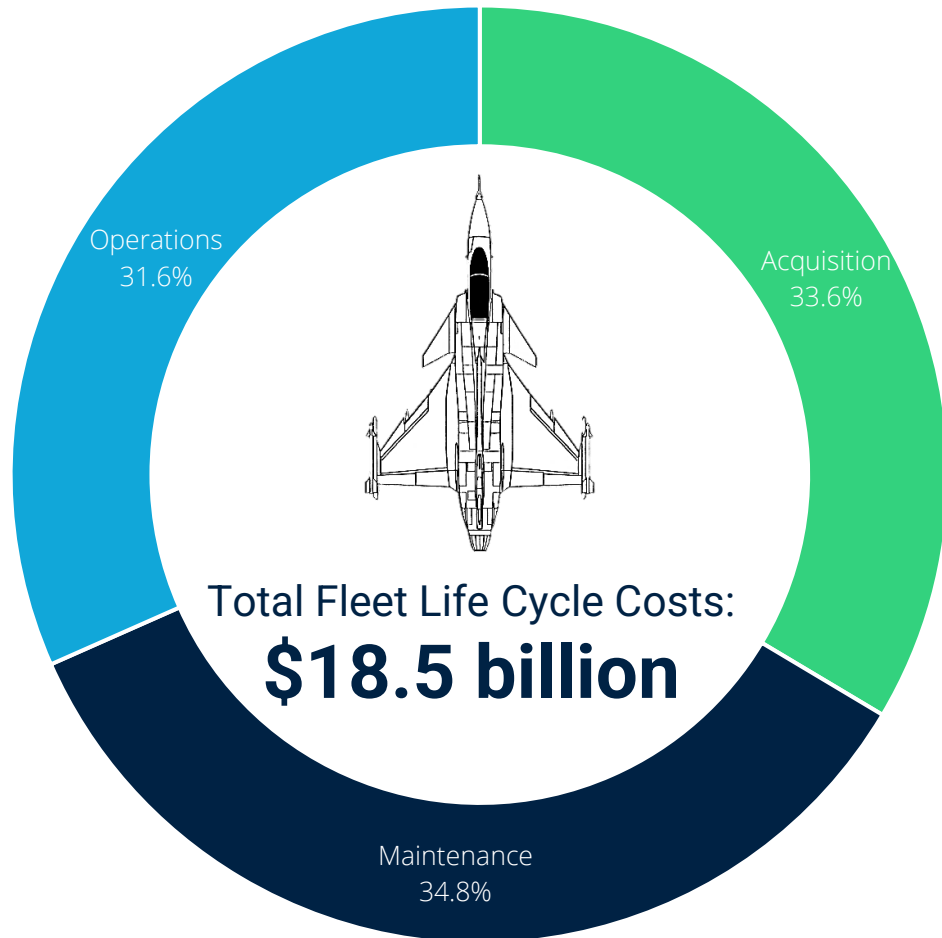
Source: Maintenance costs taken from official answers to questions in U.K. Parliament: <https://questions-statements.parliament.uk/written-questions/detail/2020-07-10/72175>

Source: Operating costs derived from U.S. Air Force and U.S. Navy operating costs taken from AFTOC and VAMOS systems reflecting actual spend on O&S costs



SAAB

Gripen C/D



Acquisition	Weapon System Unit Cost:	\$62.1 million
	Fleet Acquisition TLC:	\$6,215 million
Maintenance	Maintenance Cost (\$/FH):	\$10,815
	Fleet Maintenance TLC:	\$6,446 million
Operations	Operations Cost (\$/FH):	\$9,828
	Fleet Operations TLC:	\$5,858 million

Source: Aircraft maintenance costs taken from Saab contracts: <https://www.saab.com/newsroom/press-releases/2022/saab-and-the-swedish-armed-forces-sign-new-maintenance-contract-for-gripen>

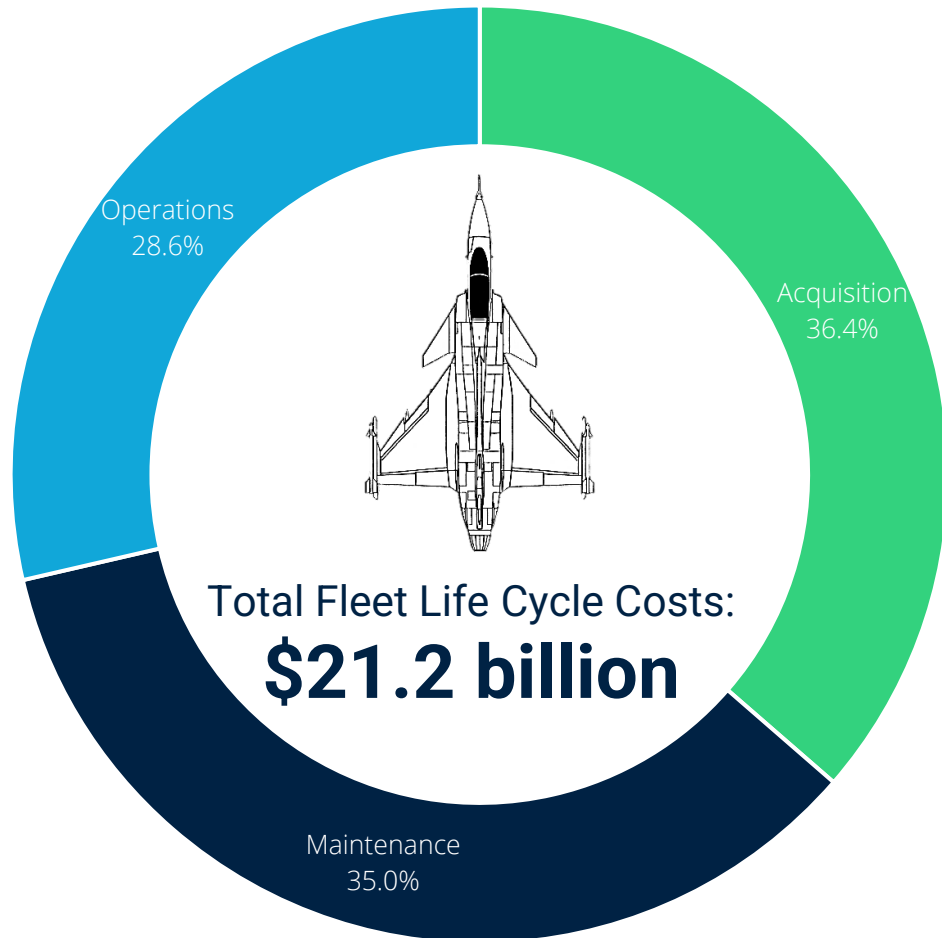
Source: Engine maintenance costs taken from GKN contracts: <https://www.gknaerospace.com/en/newsroom/news-releases/2020/gkn-aerospace-continues-to-support-the-gripens-rm12-engine>

Source: Operating costs derived from U.S. Air Force and U.S. Navy operating costs taken from AFTOC and VAMOSOC systems reflecting actual spend on O&S costs



SAAB

Gripen E/F



Acquisition	Weapon System Unit Cost:	\$75.6 million
	Fleet Acquisition TLC:	\$7,561 million
Maintenance	Maintenance Cost (\$/FH):	\$12,200
	Fleet Maintenance TLC:	\$7,271 million
Operations	Operations Cost (\$/FH):	\$9,975
	Fleet Operations TLC:	\$5,945 million

















Source: Gripen E/F unit cost taken from various development and production contracts, principally: <https://www.saab.com/newsroom/press-releases/2013/saab-receives-second-development-order-for-gripen-e-from-fmv> and <https://www.businesswire.com/news/home/20131218005899/en/Saab-Receives-Serial-Production-Order-for-Gripen-E-to-Sweden>

Source: Operating costs derived from U.S. Air Force and U.S. Navy operating costs taken from AFTOC and VAMOS systems reflecting actual spend on O&S costs

Through Life Cost Comparison



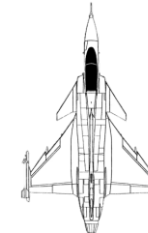
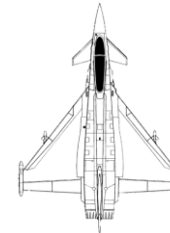
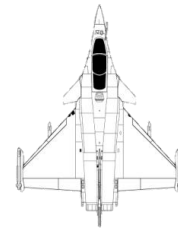
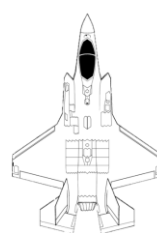
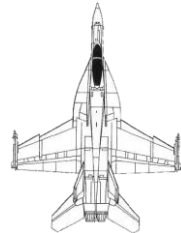
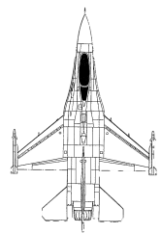
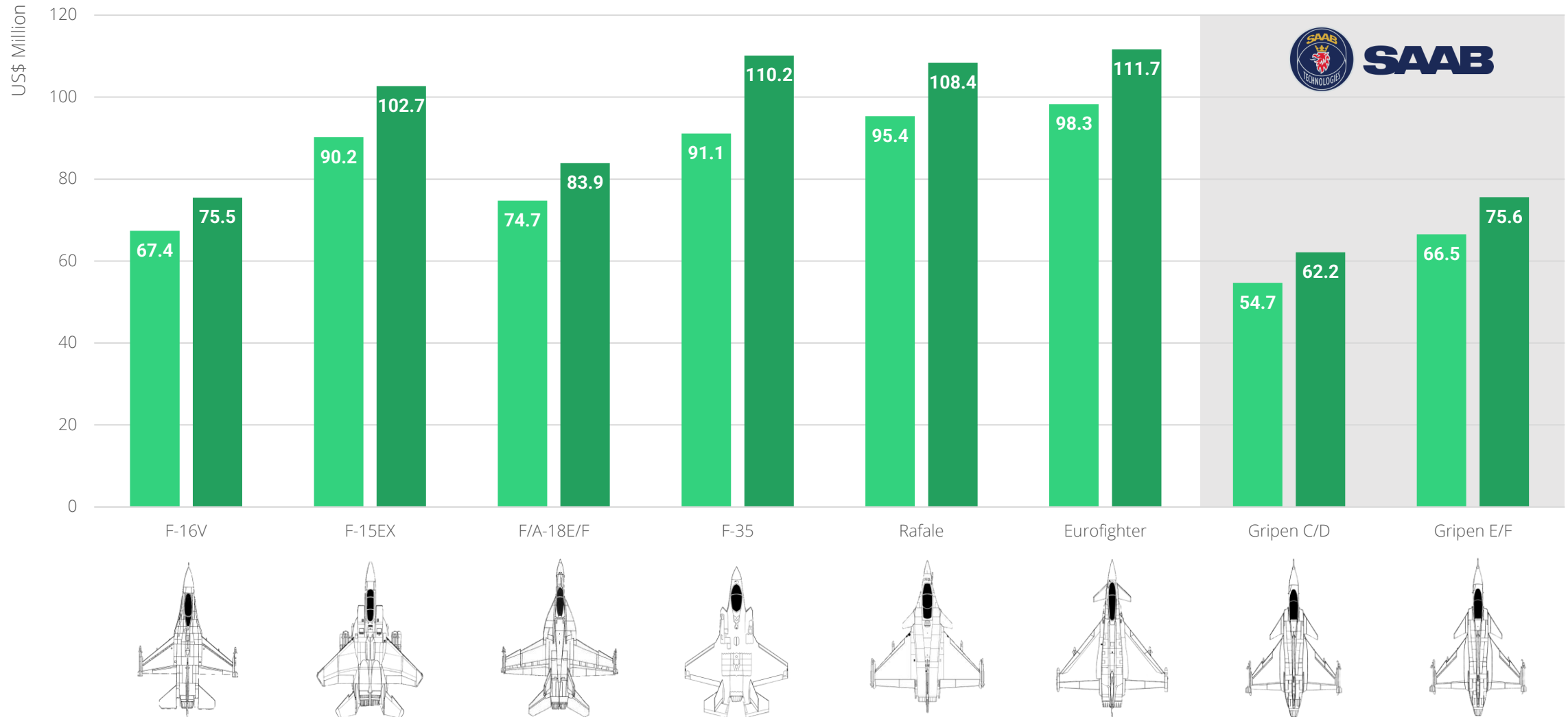
Individual Aircraft Costs

Aircraft		Acquisition Cost	Maintenance Cost	Operating Cost	Total CPFH	Through Life Cost*
	 F-15EX	\$102.7 million	\$18,803 per FH	\$15,515 per FH	\$34,318 per FH	\$356.7 million
	 F-16V	\$75.5 million	\$13,048 per FH	\$12,634 per FH	\$25,682 per FH	\$265.5 million
	 F/A-18E/F	\$83.9 million	\$14,745 per FH	\$10,989 per FH	\$25,733 per FH	\$274.3 million
	 F-35A	\$110.2 million	\$29,283 per FH	\$16,999 per FH	\$46,282 per FH	\$452.6 million
	 Rafale	\$108.4 million	\$18,045 per FH	\$13,193 per FH	\$31,238 per FH	\$339.6 million
	 Typhoon	\$111.7 million	\$15,122 per FH	\$13,853 per FH	\$28,965 per FH	\$326.0 million
	 Gripen C/D	\$62.2million	\$10,815 per FH	\$9,828 per FH	\$20,643 per FH	\$214.9 million
	 Gripen E/F	\$75.6 million	\$12,200 per FH	\$9,974 per FH	\$22,174 per FH	\$239.7 million

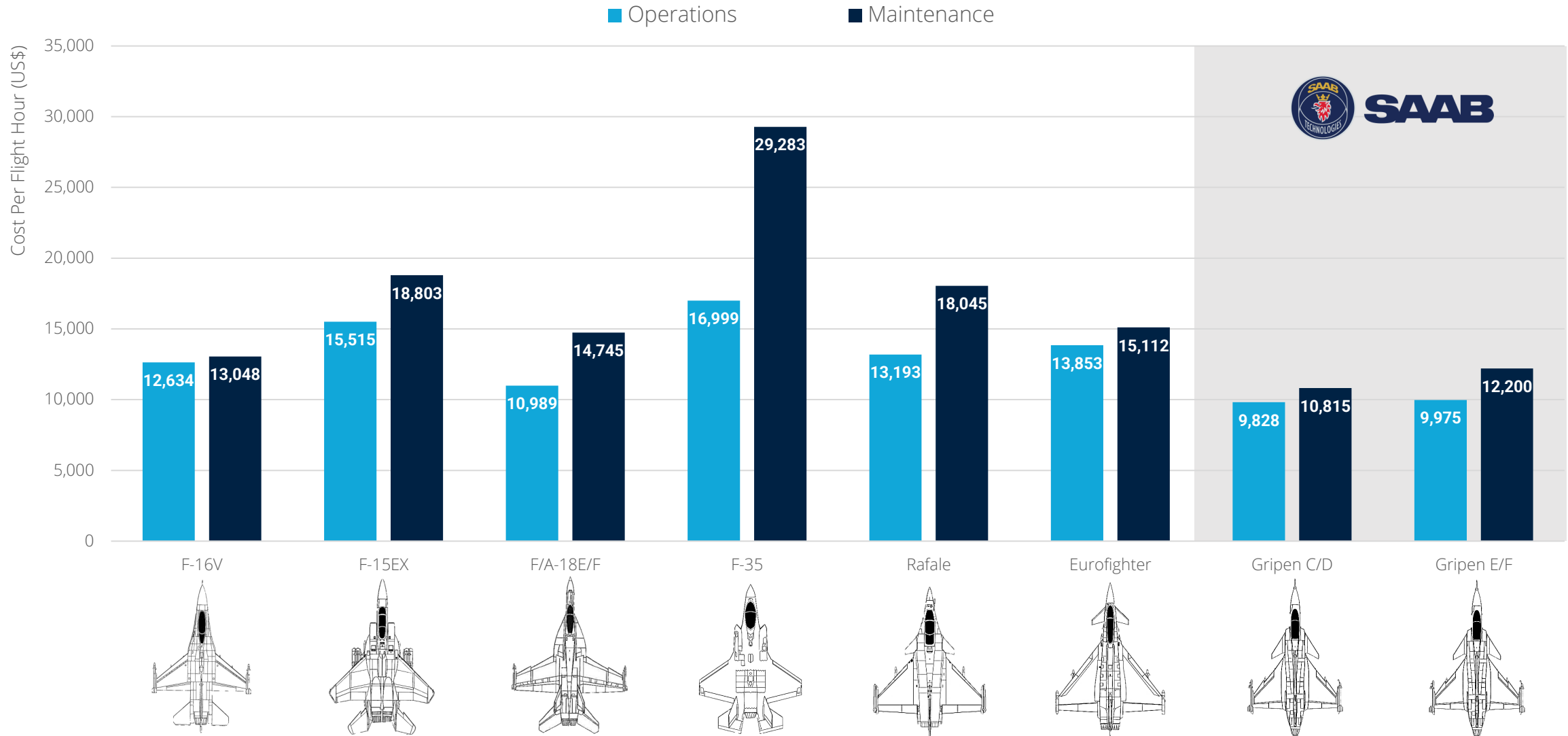
* Through life cost of one aircraft including acquisition and 37 years of operations and maintenance at an average utilisation rate of 200 hours per year.

Fighter Aircraft Acquisition Costs

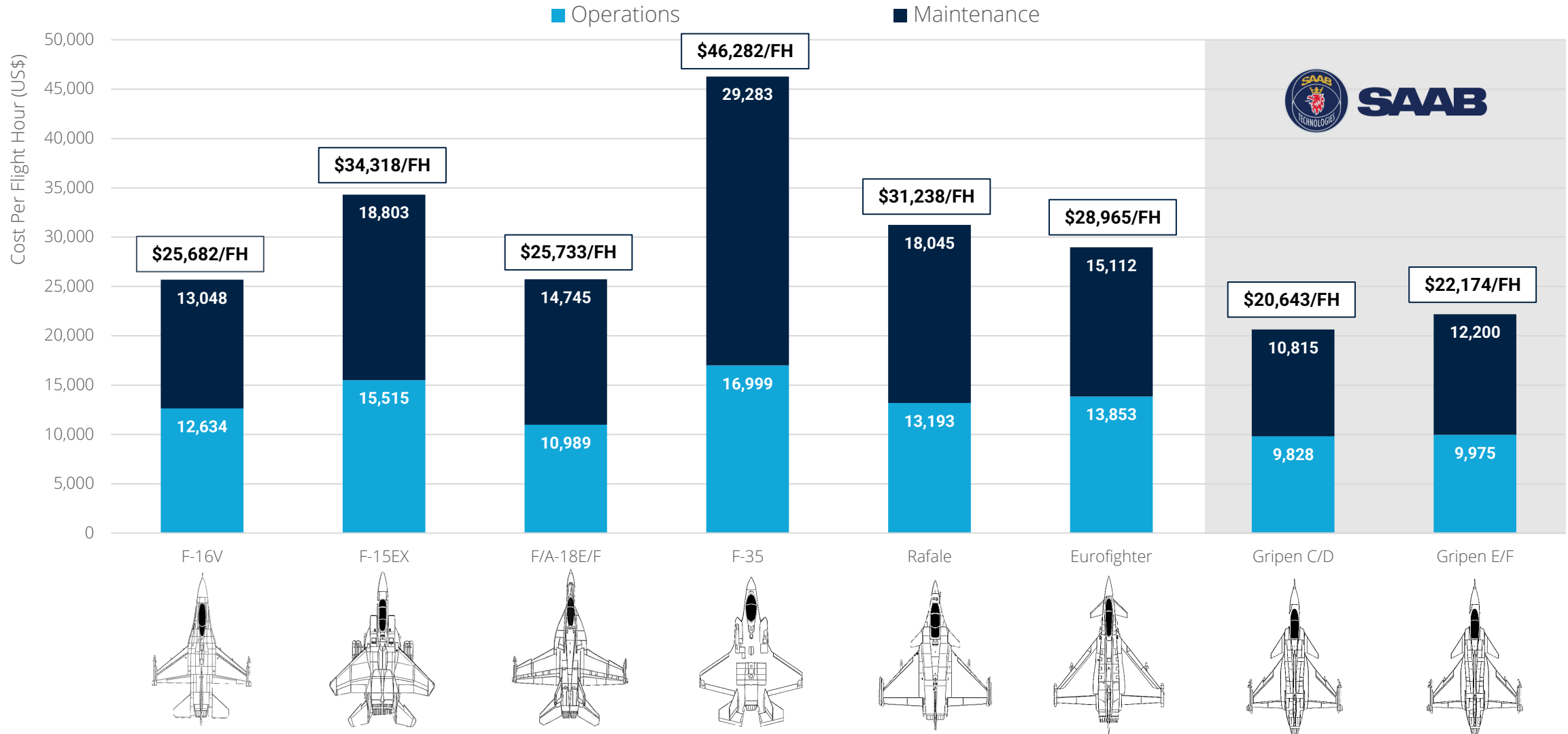
■ Flyaway Unit Cost ■ Weapon System Cost



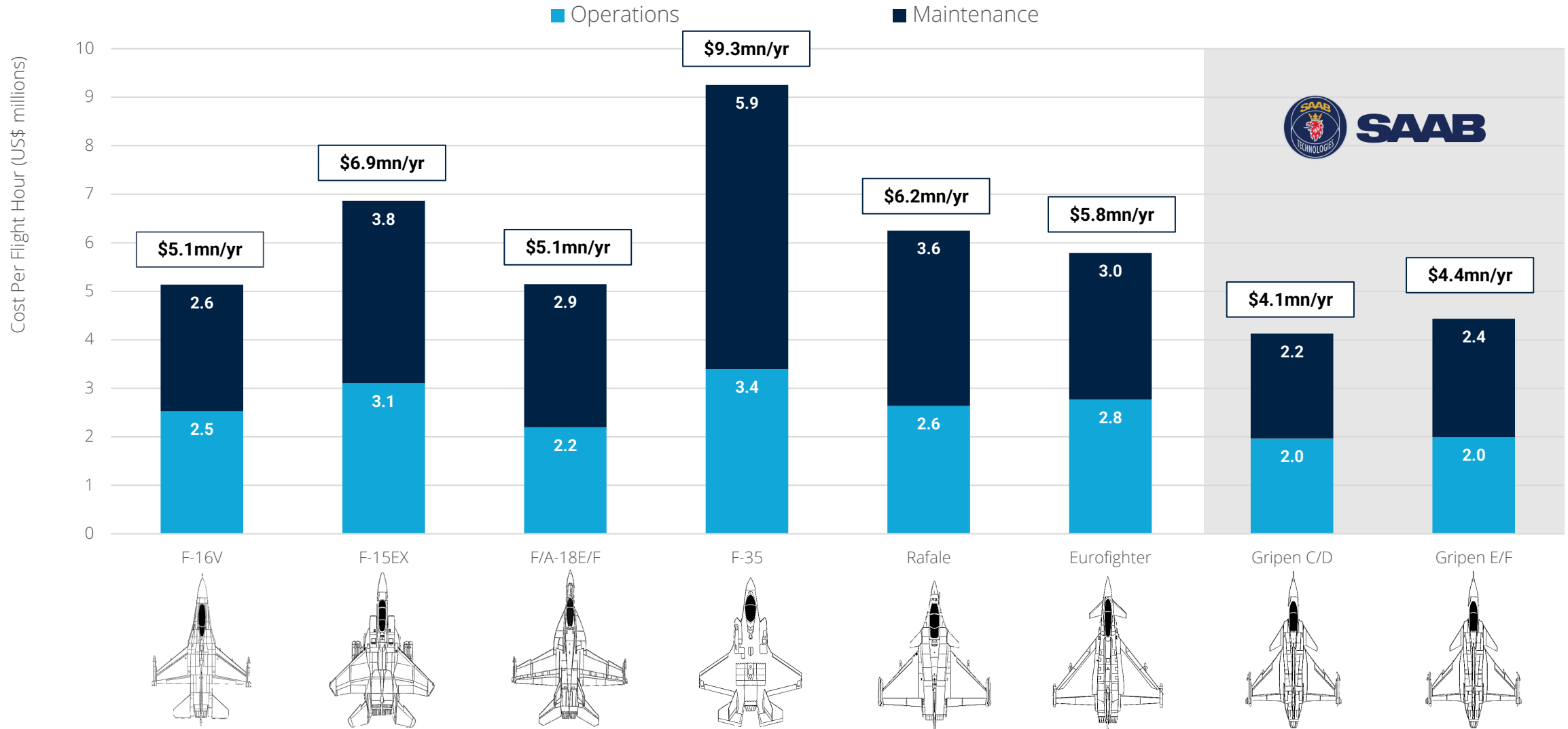
Fighter Aircraft O&M Cost Per Flight Hour



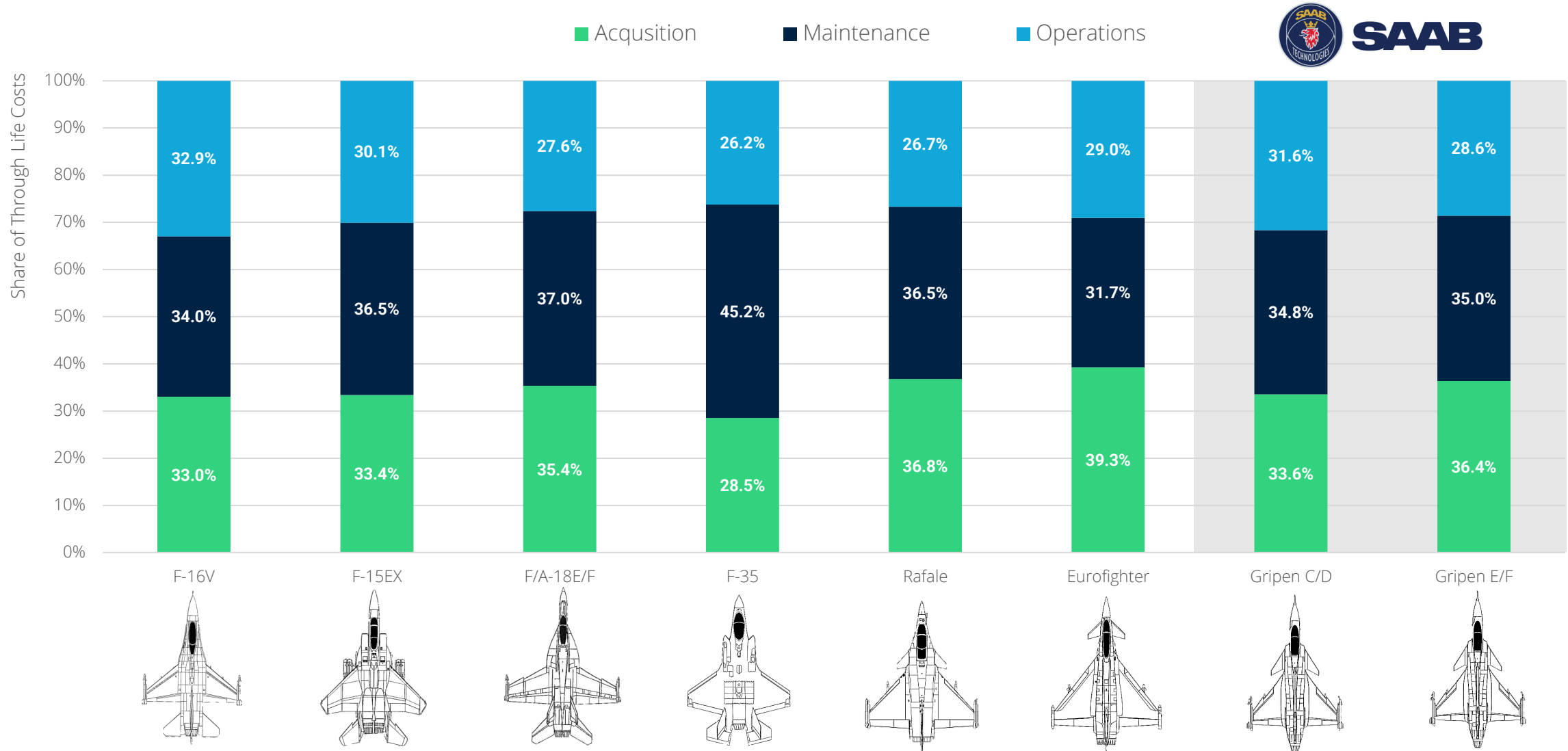
Fighter Aircraft O&M Cost Per Flight Hour



Fighter Aircraft O&M Cost Per Tail Per Year

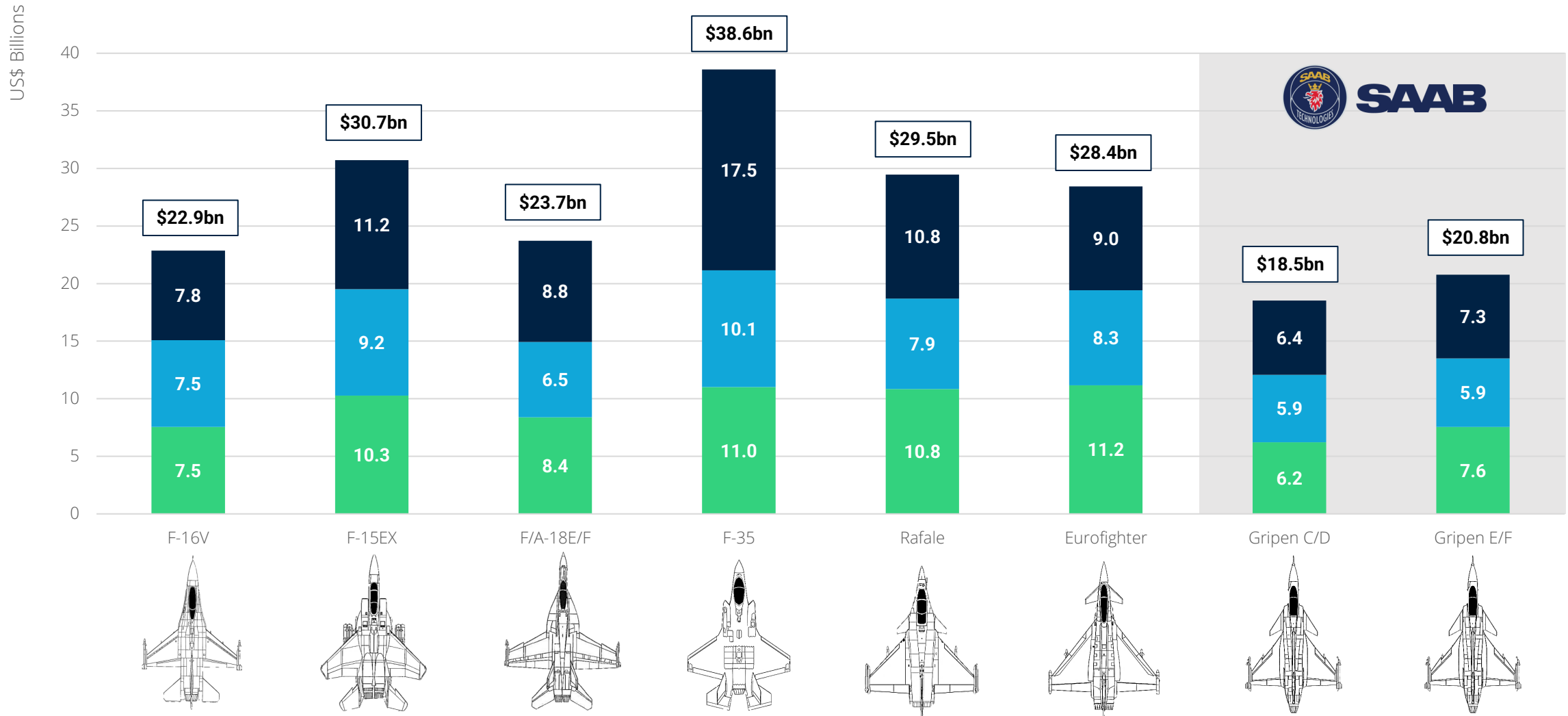


Fighter Aircraft Total Through Life Costs - Structure

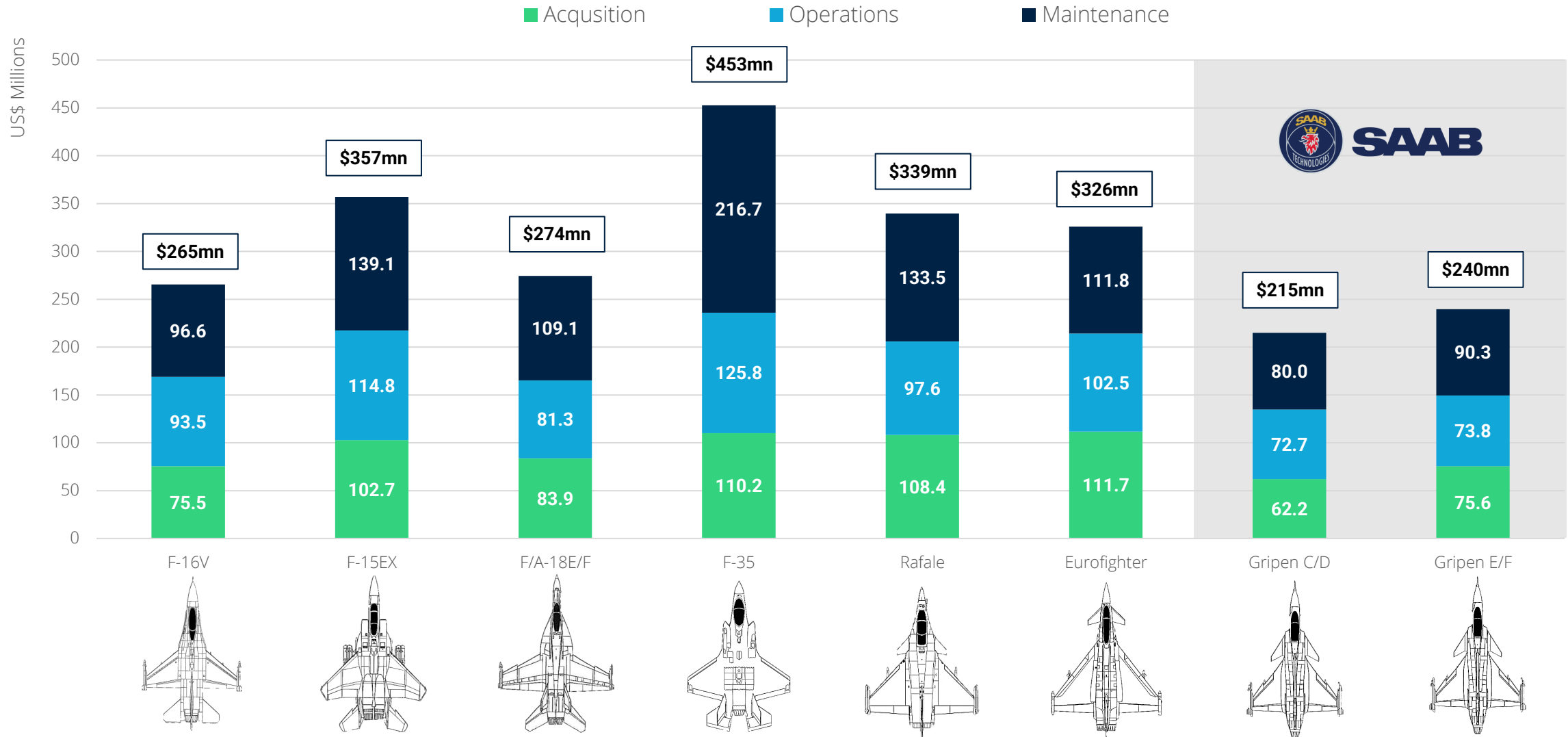


Fighter Aircraft Total Through Life Costs (Fleet)

■ Acquisition ■ Operations ■ Maintenance



Fighter Aircraft Total Through Life Costs (Per Aircraft)



Fighter Aircraft Through Life Costs

A Standardised Comparison

Aviation Week Network | Intelligence & Data Services

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On Behalf Of:

