

# Global Race to Develop Sixth-Generation Fighter Jets



**International Relations Insights & Analysis**


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# Global Race to Develop Sixth-Generation Fighter Jets

Advanced countries and aerospace firms around the world are actively engaged in research and development endeavors aimed at conceptualizing and ultimately deploying sixth-generation fighter jets.

Despite the absence of operational examples currently, the global aerospace industry has already achieved significant technological milestones during the development of fifth-generation fighter jets. These advancements include stealth technology, advanced avionics, high-performance engines, and modern air-to-air and air-to-surface armaments.<sup>1</sup>

## Generation of Fighter Jets

Fighter jet generations are typically delineated based on a combination of technological features, capabilities, and the era of development. While there is no universally agreed-upon definition, the following general criteria are commonly utilized to classify fighter jets into distinct generations:

**First Generation:** First-generation fighter jets emerged in the 1940s and were primarily subsonic aircraft. These jets often featured straight wings and were powered by early turbojet engines. Examples include the North American F-86 Sabre and the Soviet MiG-15.

**Second Generation:** Second-generation fighters appeared in the late 1950s and early 1960s. These introduced improvements such as more powerful engines, radar systems, and limited supersonic capabilities. Examples include the McDonnell Douglas F-4 Phantom II and the Soviet MiG-21.

**Third Generation:** Third-generation fighter jets emerged in the 1960s and featured significant advancements in avionics, radar, and weapon systems. These were capable of sustained supersonic flight and often incorporated innovations such as variable-geometry wings. Examples include the F-14 Tomcat and the MiG-23.

**Fourth Generation:** Fourth-generation fighters emerged in the 1970s and continued into the 2000s. These jets featured advanced avionics, digital fly-



U.S. Air Force F-16 fighter jet. (Image Credit: Lockheed Martin/Thinh D. Nguyen)

1. IRIA, Fifth-Generation Aircraft: Enhanced Agility - High Survivability - Superior Stealth Technology, International Relations Insights & Analysis, December 9, 2021. <https://www.ir-ia.com/Fifth-Generation-Aircrafts.html>



U.S. fifth generation fighter jets F-35 Lightning II.  
(Image Credit: 1st Lt. Zachary Bodner/X/@thef35)

by-wire controls, improved radar and sensor systems, and the ability to carry a wide range of weapons. Examples of fourth-generation fighters include the F-15 Eagle, F-16 Fighting Falcon, and the Russian Su-27.

**Fifth Generation:** Fifth-generation fighters represent the latest evolution in fighter jet technology. These incorporate advanced stealth capabilities, highly integrated avionics and sensor fusion systems, advanced maneuverability, and network-centric warfare capabilities. Some of the advanced fifth-generation fighters are the Lockheed Martin F-22 Raptor and the F-35 Lightning II.

While many of the developing nations are utilizing third and fourth-generation fighter jets in their air force fleet while, most of the developed countries have their hands on advanced fifth-generation fighter jets.

### Features of Sixth-Generation Fighter Jets

There are only a handful of projects in the world that have progressed to develop a prototype for sixth-generation fighter jets. All these ongoing projects have a common theme of integrating modern technologies, especially artificial intelligence (AI) into their projects. Some of the common technologies used by almost all sixth-generation fighter jets are as follows:

- **Enhanced Stealth Capabilities:** Building on the stealth technology of fifth-generation aircraft, sixth-generation fighters may incorporate even more advanced stealth features to minimize radar cross-section and infrared signatures, making them even more difficult to detect.
- **Integration of Directed Energy Weapons:** Sixth-generation fighters would feature directed energy weapons, such as high-powered lasers, for both offensive and defensive purposes. These weapons could provide precise targeting and engagement capabilities against various threats.
- **Adaptive structure:** Some of the sixth-generation fighter jets may incorporate adaptive structures that can change shape in flight to optimize aerodynamics and performance based on the current mission requirements and environmental conditions.
- **AI and Autonomous Systems:** Artificial Intelligence and autonomous systems will play a significant role in sixth-generation fighters, enabling enhanced decision-making, autonomous mission execution, and improved human-machine teaming capabilities.
- **Supercruise and Hypersonic Capabilities:** Sixth-generation fighters may have the ability to sustain supersonic speeds without the need for afterburners (supercruise) and potentially achieve hypersonic speeds, allowing for rapid response and engagement of distant targets.

- **Modularity and Scalability:** Sixth-generation fighter designs may emphasize modularity and scalability to accommodate future technology upgrades and mission-specific configurations, ensuring adaptability to changing operational environments.

## Sixth-Generation Fighter Jet Projects Under Development

Projects focusing on the development of sixth-generation fighter jets started as early as 2010. Currently, there are a few publicly known sixth-generation fighter jet development projects.

### 1. United States NGAD and F/A-XX Program

United States has one of the oldest sixth-generation fighter jet programs dating back to 2008. The U.S. Air Force's Next-Generation Air Dominance (NGAD) and the U.S. Navy's F/A-XX programs are among the key sixth-generation fighter jet projects. These jets aim to integrate stealth, supermaneuverability, advanced weaponry, and digital technology.<sup>2</sup>

NGAD, a highly classified initiative, represents a paradigm shift for the USAF, adopting a network-centric system-of-systems approach rather than relying on a single platform. Anchored by a sixth-generation fighter aircraft, NGAD will encompass manned aircraft, unmanned loyal wingman drones, and advanced command and control systems. The NGAD program requires an estimated \$16 billion over five years through 2028 for research, development, testing, and evaluation.<sup>3</sup>

The NGAD program originated from the Defense Advanced Research Projects Agency's (DARPA) Air Dominance Initiative study completed in 2014. A full-scale flight demonstrator



Concept art of the possible design for the US Air Force's future Next Generation Air Dominance stealth fighter. (Image Credit: Boeing)

2. Harrison Kass, F/A-XX: The 6th Generation Stealth Fighter That Will Replace the F/A-18, *The National Interest*, December 21, 2023. <https://nationalinterest.org/blog/buzz/fa-xx-6th-generation-stealth-fighter-will-replace-fa-18-208097>

3. Airforce Technology, Next Generation Air Dominance Programme, March 8, 2024. <https://www.airforce-technology.com/projects/next-generation-air-dominance-programme-us/>

was tested in September 2020, signaling the program's progress. Expected to replace the F-22 Raptor stealth fighters, the NGAD modern sixth-generation fighter is slated for deployment starting in 2030, with plans for 200 NGAD fighters and 1,000 collaborative combat aircraft.

Meanwhile, the Navy's F/A-XX is aimed at developing and acquiring a future sixth-generation air superiority fighter to replace the United States Navy's F/A-18E/F Super Hornet and work alongside the F-35C, with deployment scheduled to begin in the 2030s. The F/A-XX is likely to play a pivotal role in both manned and unmanned operations.

Shrouded in secrecy, not very much is known about the F/A-XX yet. Although, the F/A-XX did recently move into the design maturation phase. Three top American aerospace defense contractors – Boeing, Lockheed Martin, and Northrop Grumman – are competing to build the aircraft, while Pratt & Whitney and GE Aerospace are vying for the engine contract.<sup>4</sup>

## 2. Mitsubishi F-X Jet

The Mitsubishi F-X (also known unofficially as F-3) is a sixth-generation stealth fighter being developed for the Japan Air Self-Defense Force (JASDF). Serving as Japan's inaugural domestically developed stealth fighter jet, it is slated to replace the Mitsubishi F-2 by the mid-2030s. Its development aims to strengthen the nation's defense industry and possibly venture into the global arms market considering Japan's evolving defense stance.<sup>5</sup>

The F-X, a twin-engine stealth fighter, is engineered to achieve air superiority. According to the Japanese Ministry of Defense's classification, the technology, and capabilities inherent in the F-X align it with the criteria for a sixth-generation fighter jet.

The F-X jet would be larger than the U.S.-made F-22. The larger dimensions reflect the Ministry of Defense's intent for the aircraft to boast extensive range and payload capacity. Technologies



Concept design of Japan's F-X sixth-generation stealth fighter jet.  
(Image Credit: Japan MOD/Mitsubishi Heavy Industries)

trialed in the X-2 technology demonstrator are anticipated to be integrated into the F-X fighter. Japan's Defense Ministry has affirmed that the F-X will feature robust network capabilities and will accommodate a greater number of missiles compared to the F-35.

In December 2022, Japan, Britain, and Italy revealed their decision to collaborate and jointly develop a sixth-generation fighter aircraft by 2035 under the Global Combat Air Programme (GCAP) partnership.<sup>6</sup>

4. John Hill, Pratt & Whitney's NGAD engine meets USAF design review, Airforce Technology, February 13, 2024. <https://www.airforce-technology.com/news/pratt-whitneys-ngad-engine-meets-usaf-design-review/>

5. Mike Yeo, Japan unveils timeline for indigenous fighter jet program, Defense News, July 9, 2020. <https://www.defensenews.com/air/2020/07/09/japan-unveils-timeline-for-indigenous-fighter-jet-program/>

6. IRIA News, UK, Italy and Japan team up to develop sixth-generation fighter jets, International Relations Insights & Analysis, December 11, 2022. <https://www.ir-ia.com/news/uk-italy-and-japan-team-up-to-develop-sixth-generation-fighter-jets/>

### 3. BAE Tempest

The BAE Systems Tempest is an envisioned sixth-generation fighter aircraft currently in development in the United Kingdom for the Royal Air Force (RAF). Scheduled to enter service by 2035, it will gradually replace the Eurofighter Typhoon in the European market. The aircraft is part of the Future Combat Air System (FCAS) program, spearheaded by a consortium known as Team Tempest, comprising the Ministry of Defense, BAE Systems, Rolls-Royce, Leonardo, and MBDA UK.<sup>7</sup> The British government plans to allocate more than \$3 billion for the initial phase of the project until 2025.

According to BAE Systems, Tempest is designed to be a modular fighter jet, enabling easy adaptation to specific missions, and facilitating component upgrades throughout its operational lifespan. Featuring a delta wings design and double tail design, Tempest would incorporate stealth technology. The jet would also have the capability for unmanned flight, as well as utilize swarming technology to manage drones.<sup>8</sup>

Additionally, it will integrate artificial intelligence through deep learning algorithms and carry directed-energy weapons. The aircraft will be equipped with Cooperative Engagement Capability, enabling seamless data sharing and message coordination with other aircraft for synchronized actions. BAE Systems has unveiled that the jets' cockpit will feature a virtual display projected onto the pilot's helmet-mounted interface. Furthermore, Tempest will incorporate an adaptive cycle engine employing lightweight composite materials and advanced manufacturing processes for enhanced thermal management and cost efficiency.<sup>9</sup>



Tempest Artist Rendition. (Image Credit: Rolls-Royce/Reaction Engines graphic/UK MoD)

7. MBDA, Team Tempest, Future Combat Air System. <https://www.mbda-systems.com/teamtempest/>

8. Helena Pozniak, Tempest: the stealthy and stress-free future fighter plane, Engineering and Technology, July 13, 2021. <https://eandt.theiet.org/2021/07/13/tempest-stealthy-and-stress-free-future-fighter-plane/>

9. BAE, The future of Combat Air, Tempest, BAE Systems. <https://www.baesystems.com/en/fcas-future-combat-air-system/>

#### 4. Mikoyan PAK DP (MiG-41)

Commonly referred to as the MiG-41, Russia's Mikoyan PAK DP is the country's flagship sixth-generation supersonic fighter jet still in development. So far, no official designation has been given to the project and the name MiG-41 comes from the project that has been named izdeliye 41 (product 41).

The design for the PAK DP had been finalized by 2019. And in 2020, the Russian Ministry of Defense initiated the progress on the project. Presently, the project is still in the research and development phase. Not much information has been unveiled by Russian official sources about the progress of the project. In an interview conducted in July 2020, Ilya Tarasenko, the general director of the MiG corporation, along with the head of the Sukhoi company, revealed that the PAK DP will be based on the design of the MiG-31.<sup>10</sup>



Russia's Mikoyan PAK DP MiG-41 concept plane. (Image Credit: RenderHub/NETRUNNER\_pl)

The jet would be capable of cruising at speeds exceeding Mach 4 (5,270 km/h) and operating at high altitudes, typically between the stratopause and the tropopause, ranging from below 45,000 meters to above 12,000 meters. It would utilize a version of the Izdeliye 30 engines, presently in development for the Su-57. Reports suggest that the PAK DP will incorporate stealth technology.<sup>11</sup>

Apart from these mainstream sixth-generation fighter jet programs, China is also running a fighter jet program of its own. In February 2023, the Aviation Industry Corporation of China



Conceptual image of the next-generation fighter jets. (Image Credit: BAE Systems)

(AVIC) unveiled its concept for a sixth-generation fighter aircraft on social media. The concept showcased diamond-shaped wings and a tailless design, consistent with earlier images released in various AVIC presentations. In 2018, Chengdu Aerospace Corp purportedly submitted eight proposals for the sixth-generation fighter design, with four designs undergoing testing in low-altitude wind tunnels.

10. Army Recognition, Rostec confirms development of PAK DP MiG-41 to replace MiG-31, January 25, 2021. <https://armyrecognition.com/news/aerospace-news/2021/rostech-confirms-development-of-pak-dp-mig-41-to-replace-mig-31>

11. MiGFlug, MiG-41 – A new Mach 4+ fighter?, MiGFlug & Adventure GmbH. <https://migflug.com/jetflights/mig-41-a-new-mach-4-fighter/>





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**Cover Image:**

Artist's impression of concept aircraft flying over a terrain with Japanese, Union, and Italian flags overlaid. (Image Credit: X/@TeamTempestUK)



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