will be 17 aircraft types inside the JTRS-based "air net" by 2007. These include the Lockheed Martin/Boeing F/A-22 and the Lockheed Martin F-35 Joint Strike Fighter, still in the latter part of its development. The B-1, B-2, B-52, Fairchild A-10 and F/A-18 also are on board. Surveillance assets have joined the IP-based network, with the Northrop Grumman E-2C, RC-135, Lockheed Martin EP-3E and Northrop Grumman RQ-4A Global Hawk also equipped with JTRS radios. But the heart of this network lies with three "big-pipe aircraft" – the E-3 AWACS, Northrop Grumman E-8 JSTARS and KC-135s equipped with roll-on, roll-off beyond-line-of-sight (ROBE) relay systems.

These "are able to gather in what I call 'the haystack', the big imagery pictures, and narrow down the pixels they will send to the smaller aircraft in the JTRS circle", says Hobbins. The "big pipe" aircraft's higher transmission rate is enabled by the wide-band multi-platform Common DataLink.

Satellite upgrades

Meanwhile, 15 US military aircraft types will still lack significant datalink or IP network capability by FY09. That includes the air force's existing fleets of tankers and airlifters. Also excluded are the bulk of the non-army helicopter fleet, including Sikorsky HH-60s, SH-60s, MH-53Es, Bell UH-1Ys and AH-1Zs. In the ConstellationNet vision, there are no plans to bring the Lockheed F-117 stealth fighter on the network.

The JTRS-enabled middle layer of ConstellationNet will continue to expand in the four years after its introduction in FY09. Notably, the Boeing C-17 will receive a JTRS networking capability, allowing it to participate in the IP-based network. The UH-1Y and AH-1Z fleets, meanwhile, will be provided with Link 16 connectivity, but the bulk of the tanker and airlifter fleet will remain off the net.

In FY13, the next revolutionary connectivity leap will be achieved with the arrival of two major satellite communications upgrades. A full constellation of AEHF spacecraft will become the temporary space-based hub of the IP network, providing direct IP-based networking with 11 aircraft types, army ground stations and the DoD Global Information Grid.

AEHF will be able to send more information at faster speeds to C2 aircraft at the core of the IP-based layer that are equipped with the Boeing-developed Family of Advanced Beyond-Line-of-Sight Terminals (FAB-T). By FY13, this will include a new fleet of E-10As with a ground targeting sensor and onboard BMC2 suite.

But AEHF's role at the centre of the constellation will be short-lived, as the satellite constellation is expected to greatly diminish in significance in the seven years after FY13. Indeed, the next major communication system – the Transformational Satellite (TSAT) – will just be beginning to come online in FY13. In that year, current plans call for TSAT to be linked directly to only two aircraft – the US Army's Lockheed Martin Aerial Common Sensor, which just entered a development phase, and the US Navy's Broad Area Maritime Surveillance UAV, which has been indefinitely postponed. In FY13, TSAT also will be connected to the larger network through links to the AEHF, Advanced Polar satellite system and the Distributed Common Ground Station (DCGS) Block 10.2.

Another key networking improvement planned to arrive by FY13 will provide internet connectivity to thousands of advanced weapons. As nodes in the IP-based layer of the constellation, the weapons will receive updated targeting information while in flight. Imagery and data from the weapon's sensors, in turn, will be transmitted on the network.

Says Hobbins: "We go one step further and talk about weapons datalinks – Small Diameter Bomb [Block 2]; Joint Air to Surface Standoff Missiles (JASSM); Joint Standoff Weapon (JSOW); the Tactical Tomahawk of the future; combined effects munitions. All of these will be on a network-centric environment so that you can have an IP address for a weapon and allow turnover of that weapon to ground forces."

The last elements of the three-layer ConstellationNet strategy are to be in place by 2020. In the air force plan, there is only one aircraft – the navy's Boeing C-40 – that lacks IP connectivity or a datalink by then. The constellation includes several coalition aircraft, including the UK's BAE Systems Nimrod in the core layer and the Panavia Tornado F-3 in the outer layer with Link 16 connectivity.

More significantly, 18 aircraft are now linked to the TSAT system. Only fighters and helicopters appear to be absent from the TSAT-based web of wideband nodes. The TSAT system includes direct links to UAVs, such as the RQ-4A and future UCAV fleet, all three air force bombers, the future Airborne Laser and the bulk of the aircraft involved in the C2 constellation, although a notable absentee will be the navy's Multi-mission Maritime Aircraft.

Link 16 is the last of the current non-internet-based networks to survive in USAF's plan for 2020. Global network connectivity for the airborne network is largely based on a new fleet of satellites capable of communicating at 6,000Gb/s. On the ground are five air operations centres relying on a fibre-optic network transmitting at a rate of 10Gb/s.

"Ideally the TSAT satellite, which is going to give us 6,000Gb/s, when we hit 2020 it enables us to become self-healing and self-forming; it allows us to send any information anywhere in the world," says Hobbins, "form up this air network and be able to communicate beyond line of sight."

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The Eurofigher Typhoon *(top)* will eventually fit within the outer layer of the network. The RQ-4A Global Hawk *(above)* will be among aircraft in the JTRS-based air net