Joint Strike Fighter Electronics[1]

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Paper editing with Microsoft Word, Office 365.

INTRODUCTION

Lockheed Martin's Eagan MN division was involved in development of the electronics for the Joint Strike fighter, F-35. This paper was created in January 2015 by Judy Sloan, BS EE, former Lockheed Martin Staff Hardware Engineer. Editing for the Club's web site use by LABenson, BEE 1966, U of MN and UNISYS 1994 retiree. Revisions to this paper by project participants are welcome – send them to webmaster@vipclubmn.org.

BACKGROUND

I became aware of the pending Joint Strike Fighter (JSF) F-35 project in 1996 while working at the Winnipeg, Manitoba, Canada facility, but the story stared before 1993 in the United States. Today's fielded product is known as the F-35 Lightning II; the prime contract was awarded to Lockheed Martin Aeronautics (LM Aero) in Fort Worth, Texas, who continues to manufacture the aircraft and lead upgrade efforts to the present day.

Many countries, companies and teams made up the partnership that designed and produced this aircraft, but the information contained herein will be devoted to the efforts performed at the Lockheed Martin facility[2] in Minnesota.

[1] Clicking on a Contents line will quick scroll to that page.
[2] This facility was the UNISYS plant 8 in Eagan, MN before Loral bought the UNISYS Defense Systems Division and before LMCO in turn bought some of the Loral holdings.

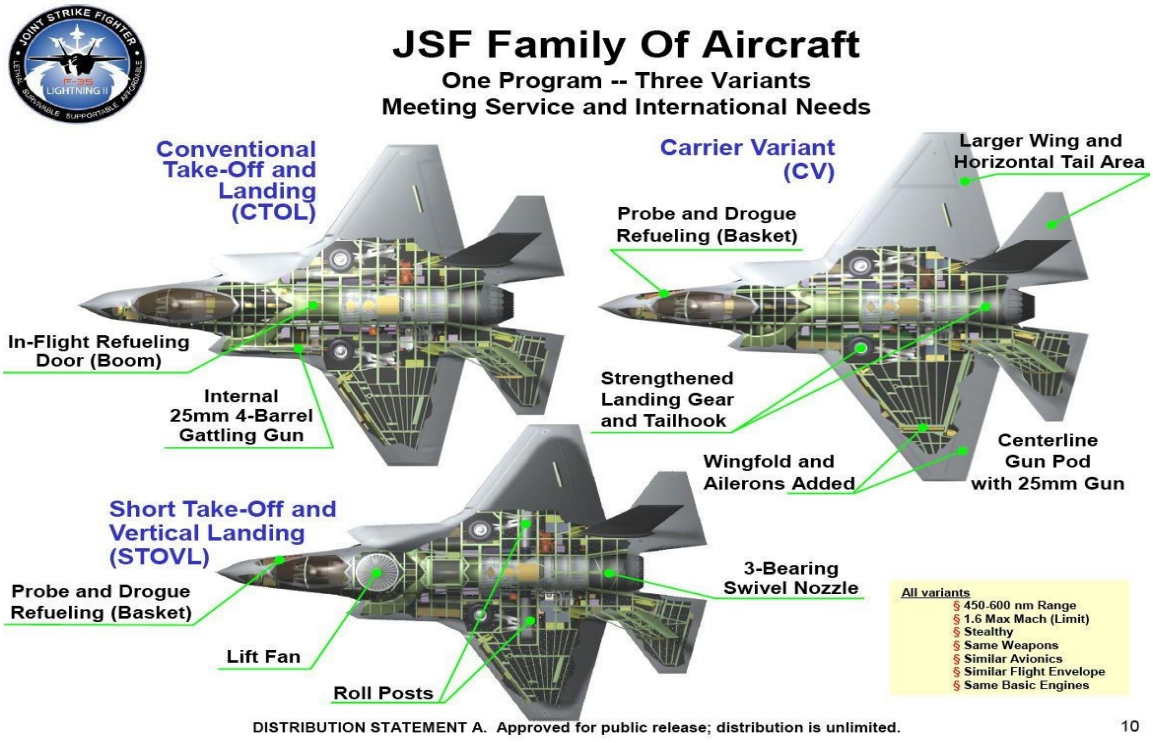

Figure 1. Aircraft variations

MINNESOTA DEVELOPMENT

The Integrated Core Processor (ICP) is the heart of the mission computer, this and several key assemblies were created at Lockheed Martin's Tactical Systems facility, 3333 Pilot Knob Road, Eagan, MN 55121. That facility was closed in 2012.

Contract Start

The F-35 development contract was awarded in 1996, then the production contract was awarded to Lockheed with partners Northrop Grumman and British Aerospace Enterprises on October 26, 2001. A celebration was held in the Eagan cafeteria; I remember the cake and drinks, but at the time did not realize the role my coworkers and I would eventually play in the systems development.

I was analyzing technology and requirements on the F-16 Block 40 upgrade project when the JSF production contract award was announced. When the F-35 prime contract was awarded to the LM Aero, the Eagan group became involved.

Within a few short months, the enormity of the F-35 effort became apparent. The F-16 Block 40 work was transitioned to Raytheon and LM Eagan personnel focused their efforts on the F-35 development tasks.

From 2002 to 2010 the Eagan JSF team organized and hosted numerous meetings at the Eagan facility that involved dozens of companies and hundreds of people. Each meeting was an incredible feat of logistics and technical exchanges.

Figure 2. Numerous companies formed the F-35 development and production teams.

ICP Efforts in MN

The ICP chassis hosted a number of circuit assemblies that included power converters, general processors, and specialized signal processors.

A large number of people at the Eagan facility put forth great efforts in developing the General Processor (GP) and the General-Purpose Input Output (GPIO). I had the honor of working closely with Gary Hokenson, Don Degerstrom, Dave Senechal, Charles Grimner, Reed Churchward, Richard (Smitty) Smith, Gerald Brown, Josh Rensch, Art Perez, Kim Tharp, Tom Pogemiller, and John Westberg.

So many others; each day brings more names to mind and more parts of the ICP performed in Eagan.

Strategy

The ICP hardware needed to be developed rapidly to avoid any impact to the software schedule. As complex and challenging as the hardware was, the software overshadowed all in complexity, detail, and sheer volume of work.

Schedule Is King! To this day, I remember that phrase fondly. It firmly set the expectations and attitudes in designing the ICP hardware and brought to bear the maximum power of engineering creativity.

The components and systems within the F-35 were developed by integrated product teams (IPT's). These teams included a wide range of people from research, engineering, manufacturing, finance, legal, contracts, procurement, and program management. The IPT leads were some of the busiest multitasking people I knew.

GP & GPIO

The General Processor and General-purpose Input/Output assemblies were implemented in Eagan, MN and manufactured in Clearwater, Florida. The Eagan team gathered requirements from many partners.

E-Box Test System

Dick Erdrich's famous E-box (named after himself) became a necessity to test the GP & GPIO circuit assemblies, see http://vipclubmn.org/computersAF.html#JSF. These test fixtures gave Eagan hardware designers a head start and were also used for software development by the Ft. Worth (LM Aero) teams.

Because of these test fixtures, the hardware could be developed before the ICP chassis was completed and hardware was able to keep ahead of the software.

The E-boxes were a 100% Eagan design and construction and continue to play an important role in the F-35 systems testing.

1394b Interface

Many of the JSF communication systems are fiber based, but some systems employ a ruggedized version of the 1394 interface.

Through direction from Eagan manager Gary Hokenson and inputs from partners and LM Aero team leads, my partner, Don Degerstrom and I implemented the 1394 interface on the GPIO.

FPGA Verification Team

A group of people that made up a unique team that simulated, tested and verified the functions of the Field Programmable Gate Arrays. An entity not rivaled on a global scale.

Leader of the team and instrumental to its formation: Josh Rensch

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The JSF electronics, like the majority of electronics in its' time, made use of field programmable gate arrays (FPGA's). These transformative devices are a marvel of ingenuity and creativity that allow hardware functionality to change with the application of a configuration file.

As a simplified description, an FPGA is a marvel of programmable (changeable) microscopic switches etched into a thin silicon wafer. The number of programmable devices within an FPGA at that time (circa 2006) could have been as high as 3,000.

Without changing its outward physical appearance, the FPGA can greatly change its internal characteristics by loading a program through either a serial or parallel port.

Fragmented Details

- The ICP backplane was designed in Eagan, but manufacturing was performed by a partner in Norway. Engineer Steve Lein was the main interface person.
- The ICP backplane is a hybrid of electrical copper traces and optical fibers.
- The original Fibre Channel transceiver was developed by Eagan's Chuck ?. It was later taken over by Harris' Common Components line.
- Hamilton Sunstrand was tasked with aircraft lighting with 1394 interface.
- The weight of a Volkswagen beetle had to be removed from the production design; even the tiniest component was included in weight estimates.
- A modified 1394b interface was developed by the vehicle systems team and became the SAE Standard.
- There were numerous reasons given as to why the Lockheed X-35 was the concept winner over the Boeing X-32, but I've always felt the true reason was that the Boeing X-32 lacked the aesthetic quality needed to inspire thousands of people to fund, develop, build, procure, fly, and support this aircraft.
- Mind-ready never had the technology that Dap did. Eventually Dap's Firespy series overwhelmingly dominated the JSF 1394 test platform.
- The LM Star test platform was never popular but was pushed because work needed to be shared across all states. A unit was delivered to Eagan for testing with GP/GPIO hardware, 6' x 5' x 3'. Unknown as to its present-day usage.

EPILOGUE

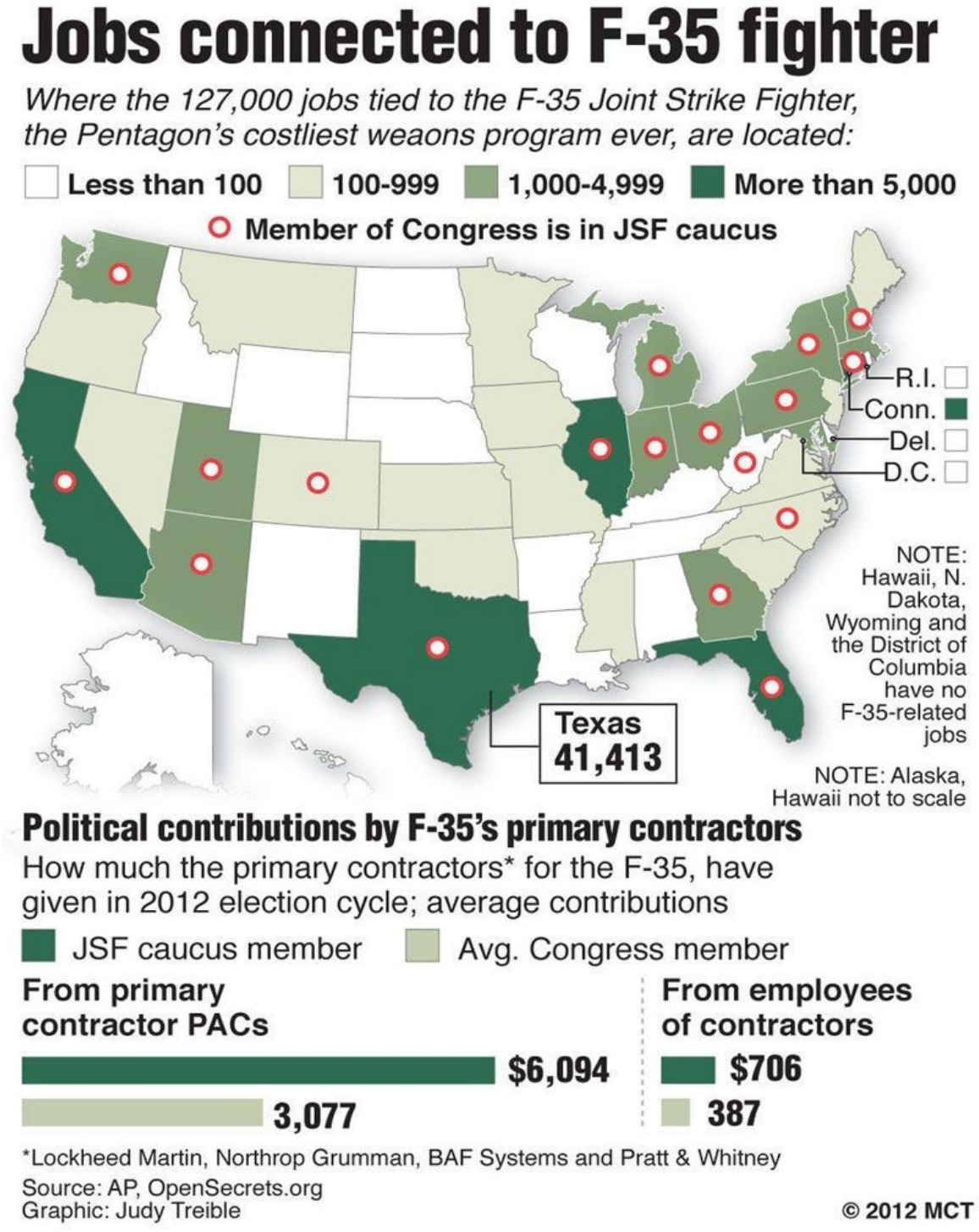
In November of 2010, the closing of the Eagan, MN facility was announced. Many programs were still in progress including upgrades for JSF ICP assemblies. The JSF related efforts were transitioned to Owego, New York. Key hardware, software, test and logistics staff were transitioned to there as well.

As of January 30, 2015, 3333 Pilot Knob, Eagan MN 55121 stood vacant. As of May 2018, a very small group of engineers in a small Eagan facility continued to provide support to the JSF electronics.

This was the last major systems platform electronics developed in Minnesota; joining the Athena launch systems, the four generations of the Naval Tactical Data Systems (NTDS), five decades of FAA's of Air Traffic Control systems, the P3C, the S3A, the B2, the Canadian Patrol Frigate, and the Minute Man launch control systems as innovation gemstones of our Legacy.

OUTSIDE OF MINNESOTA

A program of this magnitude (effort and funding) would not have been possible without solid congressional support. The only way to get this funding approved was to involve as many voting districts across the US as possible.



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Dick Erdrich's mini-story: http://vipclubmn.org/computersAF.html#JSF.

Figure 3. Refueling socket is obvious just behind the cockpit.