The Opportunity Space for Wireless Sensor Systems in Launch Vehicle Platforms and Production

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Boeing Defense, Space & Security

Divisions

- **Autonomous Systems** – Develops and produces remotely piloted aircraft and submersibles. Manages Boeing's Insitu subsidiary.
- **Commercial Derivative Aircraft** – Develops products for military and government customers globally based on proven commercial platforms including Boeing's world-class 7-series aircraft.
- **Global Operations** – Leads Defense, Space & Security's international subsidiaries seeks opportunities for additional global growth.
- **Missile and Weapon Systems** – Manages Boeing's portfolio of strategic missile and defense systems and weapons systems.
- **Phantom Works** – Creates and advances new products and capabilities by drawing on its expertise in innovation, advanced experimentation and prototyping.
- **Space and Launch** – The world's largest satellite manufacturer also offering other space and intelligence systems. The division houses Boeing's more than 60 years of space exploration expertise and manages Boeing's share of United Launch Alliance and United Space Alliance.
- **Strike, Surveillance and Mobility** – Manages Boeing's current and future portfolio of fixed-wing military and surveillance aircraft, including fighters and commercial derivative platforms, and support of key platforms such as the executive transport fleet, which includes Air Force One.
- **Vertical Lift** – The world's largest provider of military rotorcraft with a diverse portfolio of cargo, tiltrotor and attack platforms.

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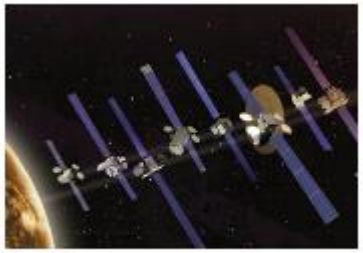
Phantom Express


Boeing Satellite Family


United Launch Alliance


Global Positioning System


Crew Space Transportation (CST) -100 Starliner


International Space Station


Space Launch System


KC-46A Pegasus Tanker


AH-64 Apache


CH-47 Chinook


Airborne Early Warning & Control


Air Force One


Autonomous Systems


B-1B Lancer


B-52


C-17 Globemaster III


F/A-18 Super Hornet

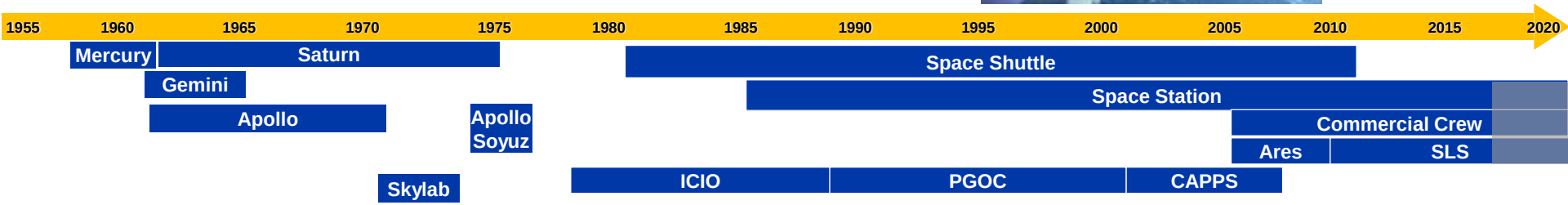

Ground-based Midcourse Defense


ICBM / GBSD


V-22 Osprey

Boeing Human Space Flight Heritage

Boeing Space Exploration



Boeing Human Space Flight Heritage

Boeing Space Exploration

1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

- Mercury
- Saturn
- Gemini
- Apollo
- Apollo Soyuz
- Skylab
- Space Shuttle
- Space Station
- Commercial Crew
- Ares
- SLS
- ICIO
- PGOC
- CAPPS

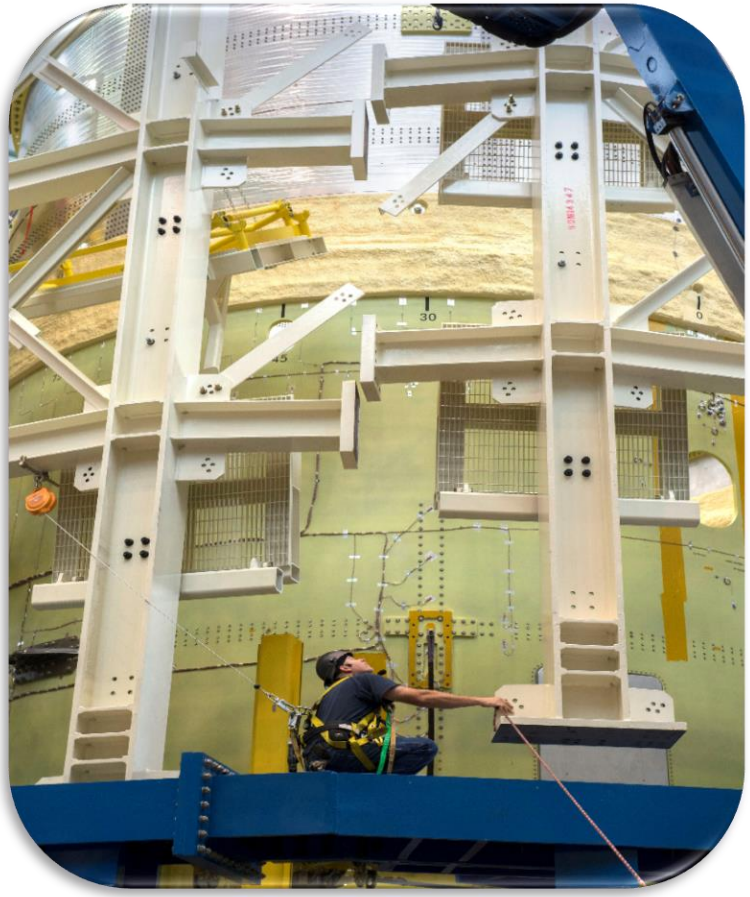
Boeing's Interest in Passive Wireless Sensor Technology

Lighter Weight

- Eliminates wires, brackets and clamps

Less Complexity & Higher Reliability

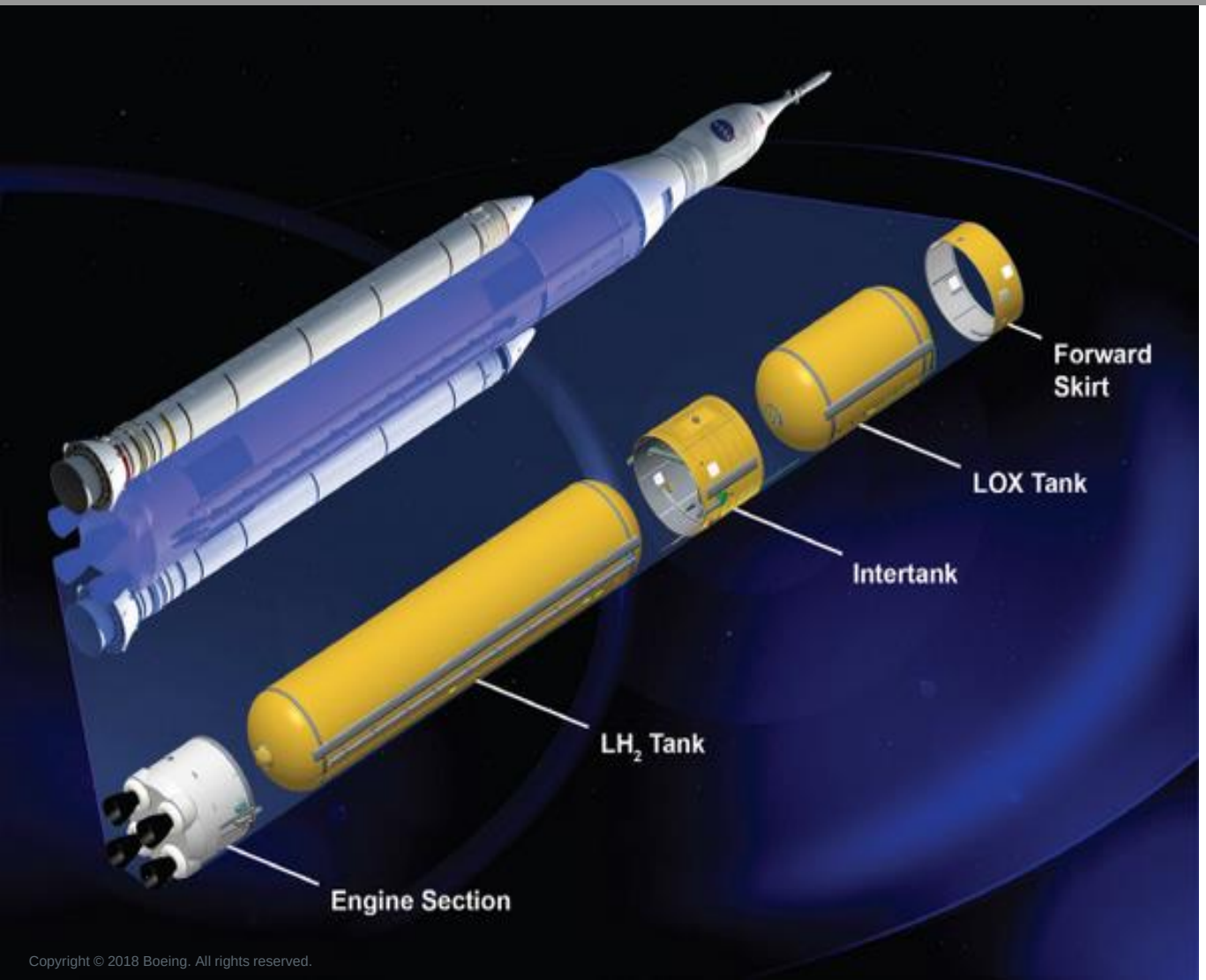
Reduction in manufacturing time



PWST is an enabler

Flight and Ground Support Application Spaces for Wireless Sensors

Boeing Space Exploration

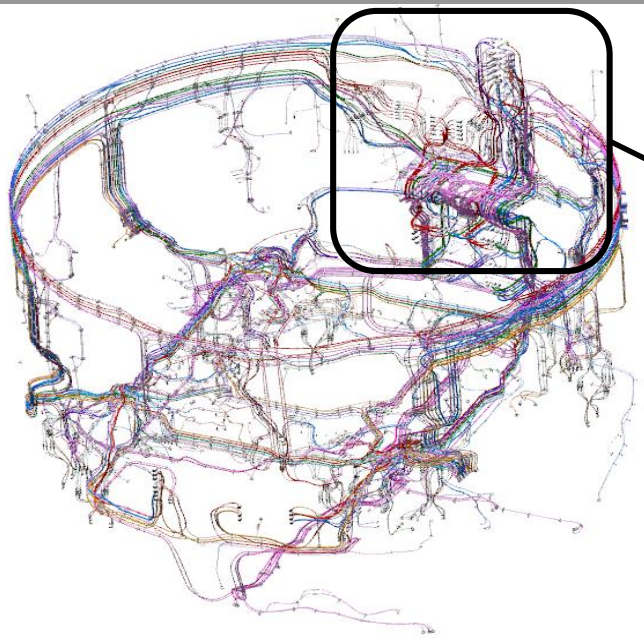


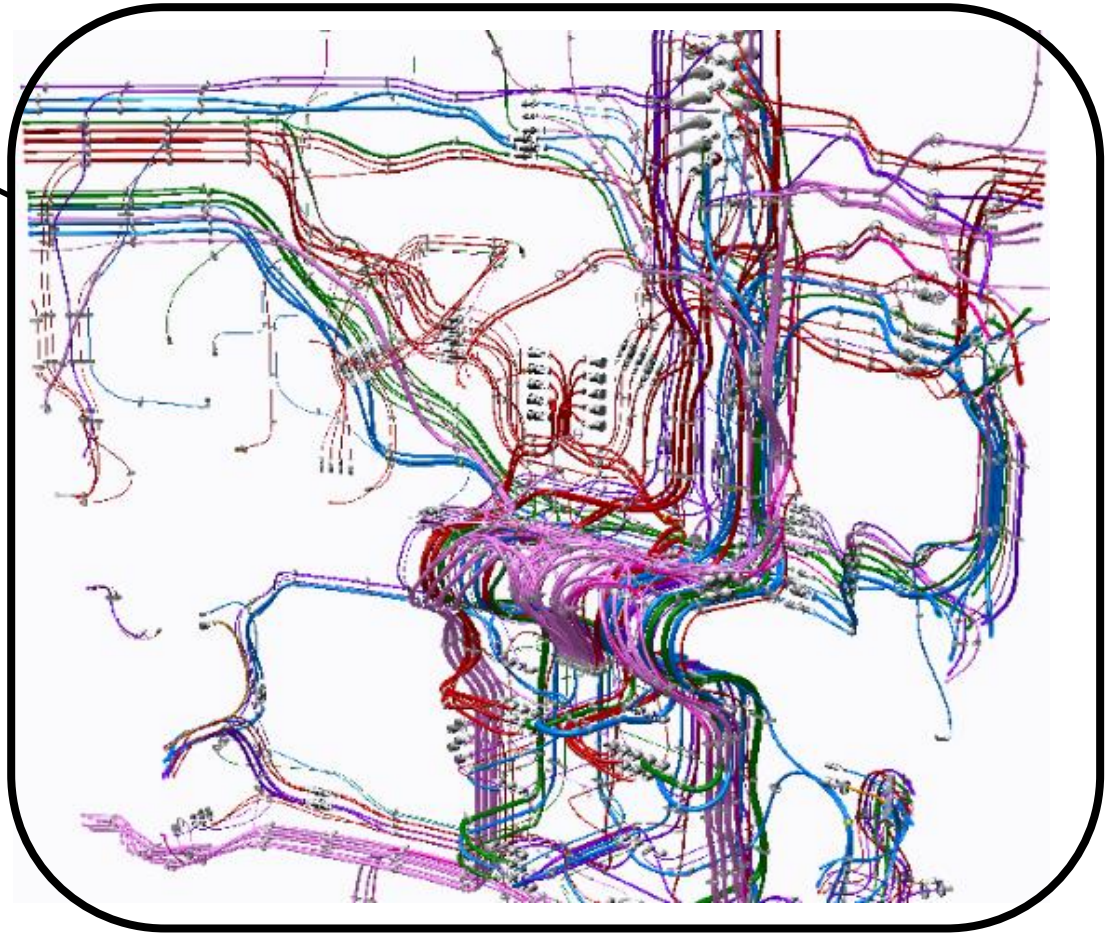
Over 1100 sensors are installed on the Space Launch System Core Stage – every section of the vehicle has sensors inside and out

- Pressure Sensors
- Temp Sensors
- Microphones
- Thermocouples
- Accelerometers
- Strain Gauges
- Calorimeters
- Radiometers
- Position sensors
- POGO sensors
- Fluid Level sensors

Highly Complex Wire Harness Environments

Boeing Space Exploration





Harness Colors Represent Different Functional Classes

Purple = Data

Eliminate/Mitigate Wires Saves on Weight/Integration

Aut
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Flight and Ground Support Application Spaces for Wireless Sensors

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Approximately 20% of the SLS Core Stage sensors are flight critical

Non-flight critical sensors are a great consideration for wireless sensors

- Significant reduction in wiring; reduces weight, cost, production schedule

Flight and Ground Support Application Spaces for Wireless Sensors

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Wireless sensors could be a safer alternative for measurements required inside the cryogenic fuel tanks

- The Liquid Hydrogen (LH2) and Liquid Oxygen (LOX) tanks require level sensors for engine shutoff
- The LH2 and LOX tanks also contain temp sensors and fill sensors
- Majority of these sensors are flight critical, so the wireless sensor alternative would have to be proven safe and reliable for this harsh and safety critical environment

Test Application Spaces for Wireless Sensors

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Once assembled at Michoud Assembly Facility, the SLS Core Stage will go to Stennis Space Center for Green Run Testing. This Green Run Test will be the final test of the core stage and engines before flight.

- Over ***400*** additional sensors are installed for the Green Run Test

Overcome cabling, access and sensor location and weight constraints to enable the right data and the right place with faster installation and reconfiguration capability.

Manufacturing Benefits

Less wiring means….

- Less drawings and work instructions
- Less installations; wiring, brackets, clamps, etc
- Less post installation testing
- Less parts to qualify for flight
- Less parts that can fail or cause failure to nearby hardware; higher reliability and less rework

Eliminate the Wires…
Enable Faster Manufacturing; increase reliability; reduce weight


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