
S.I.F – Yet another Spacecraft Interconnection Standard

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What is SIF?

- “Standard InterFace”
- A specification for inter-operable satellite avionics
- First conceived in Spring 2005
- Now > 10 nodes functioning on-orbit

SIF enables very rapid avionics development, and satellite integration and test, in an environment of shifting requirements.

Design Architecture

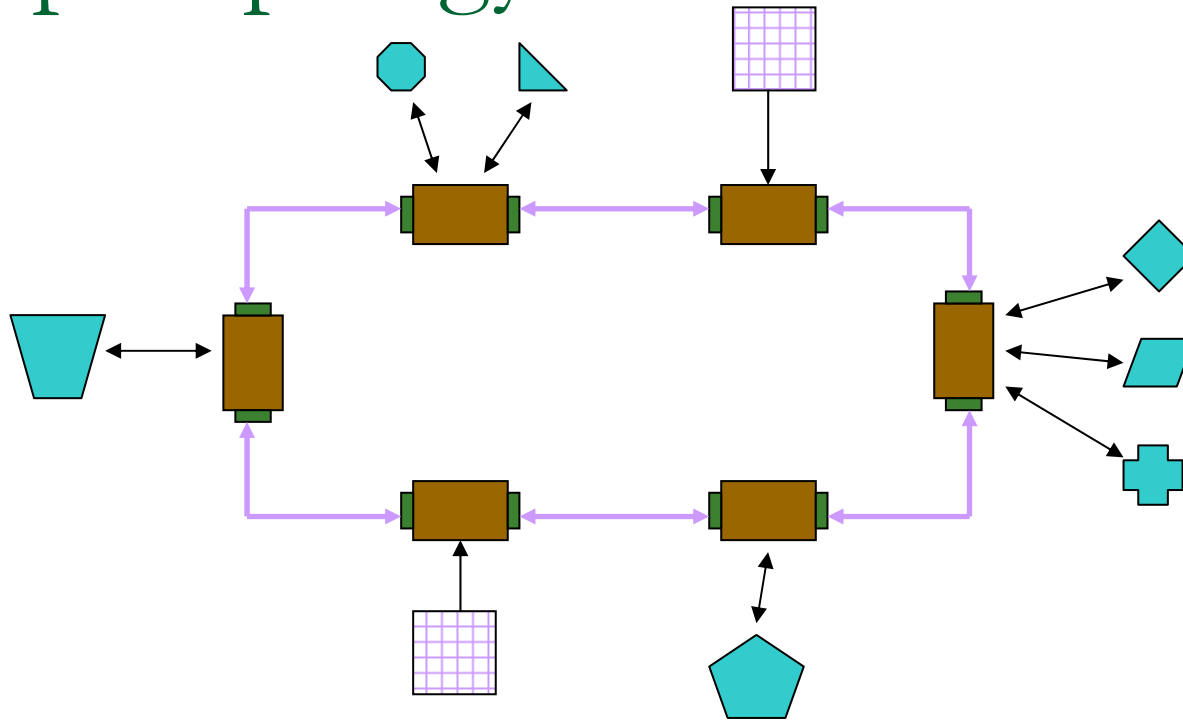
- Distributed modular architecture
 - Capabilities can be added or removed
 - Reduce the mass of wiring
- Standard power and data interface
 - Simplify testing of individual modules before integration
 - Reduce documentation and design

Interface Elements

Use COTS standard elements to minimize innovation required.

Element	Standard	Source
Connector	9-pin D-sub	Everywhere
Power	Redundant +28 V DC	Military, aircraft, spacecraft
Data Bus	ISO-11898-3 CAN	Heavy trucking
Software	CANopen	Light rail, factory-floor automation

Loop Topology



- Standard cables
- Many small harnesses
- Ease of expansion

Fault Tolerance

SIF is extremely robust, without complex redundancy management

- Three +28 V power circuits
 - Short to ground blows fuse: 2 busses remain
- ISO-11898-3 CAN is operational through:
 - Conductor short to GND, ± 80 V
 - Conductor open-circuit
 - Differential pair shorted together
- Loop Topology provides backup path

Test Equipment

Hardware

- +28 V power supply
- USB-to-CAN widget
- Simple switch/fault box

Software

- Commercial CANopen monitor

\$1000 in GSE serves whole satellite



SIF Devices

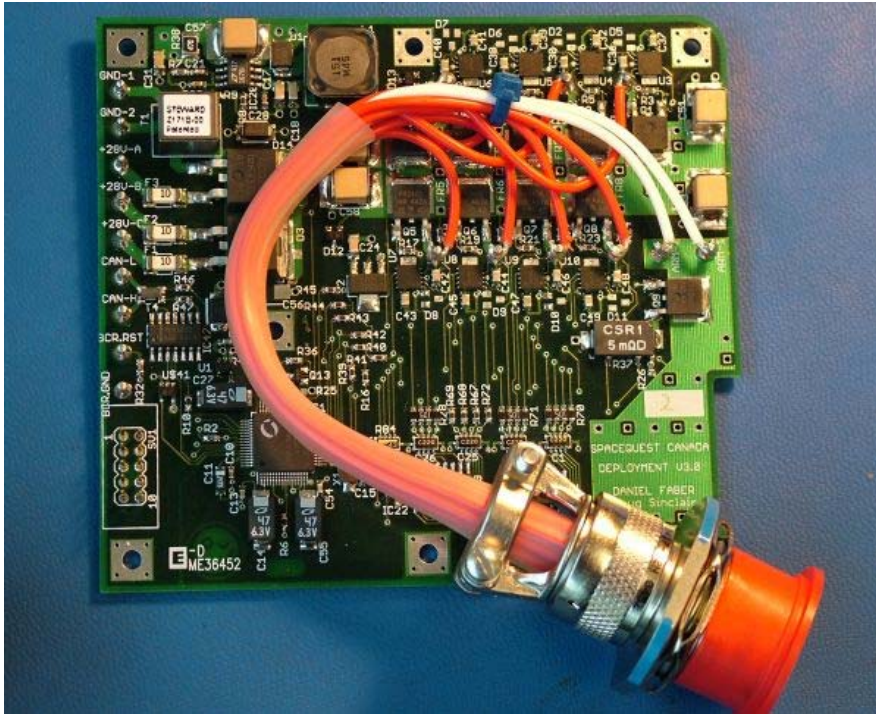
- In just one year, a small team has produced:
 - General Purpose Terminal
 - Deployment Terminal
 - Battery Charge Regulator
 - Linux Computer
 - Dual-Speed Modem
 - Power Conversion Distiller
 - 11-port Ethernet Switch
- Flying Now!
- 2007 launch

General Purpose Terminal (GPT)

- Interface to sensors, actuators and payloads
- 12 channel glueless analog interface to simple sensors
- 6 +28 V H-bridge power switches
- 2 uncommitted DC/DC converters
- Digital SPI, parallel, RS-485 interfaces



Deployment Terminal



- 8 pyro circuits
- Pre-arm/Arm/Fire inhibits
- Programmable pulse amplitude and duration
- Full built-in test

Battery Charge Regulator

- Charge battery from 4 solar panels
- Detect satellite separation
- Provide power to SIF bus
- Power and command deployment motors



Linux Computer and Dual-Speed Modem

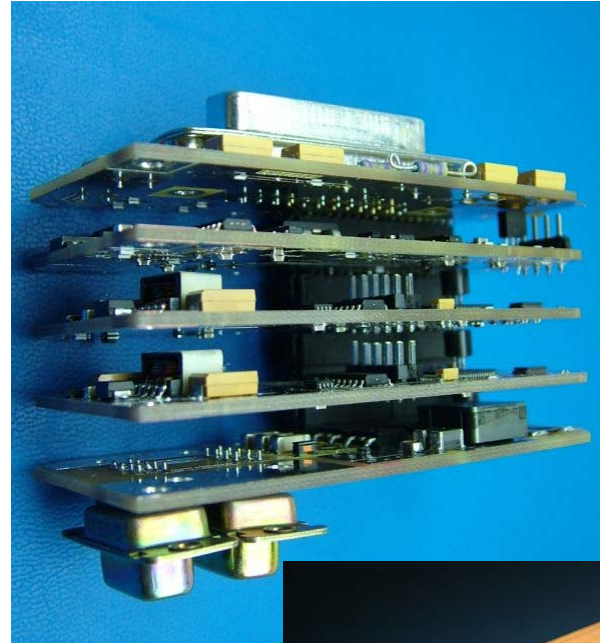


- Space/Ground TCP/IP link
 - 1.4 Mbps primary (S-band)
 - 9.6 kbps auxiliary (VHF/UHF)
- Massive COTS solid-state memory
- Identical hardware on satellite and in ground station

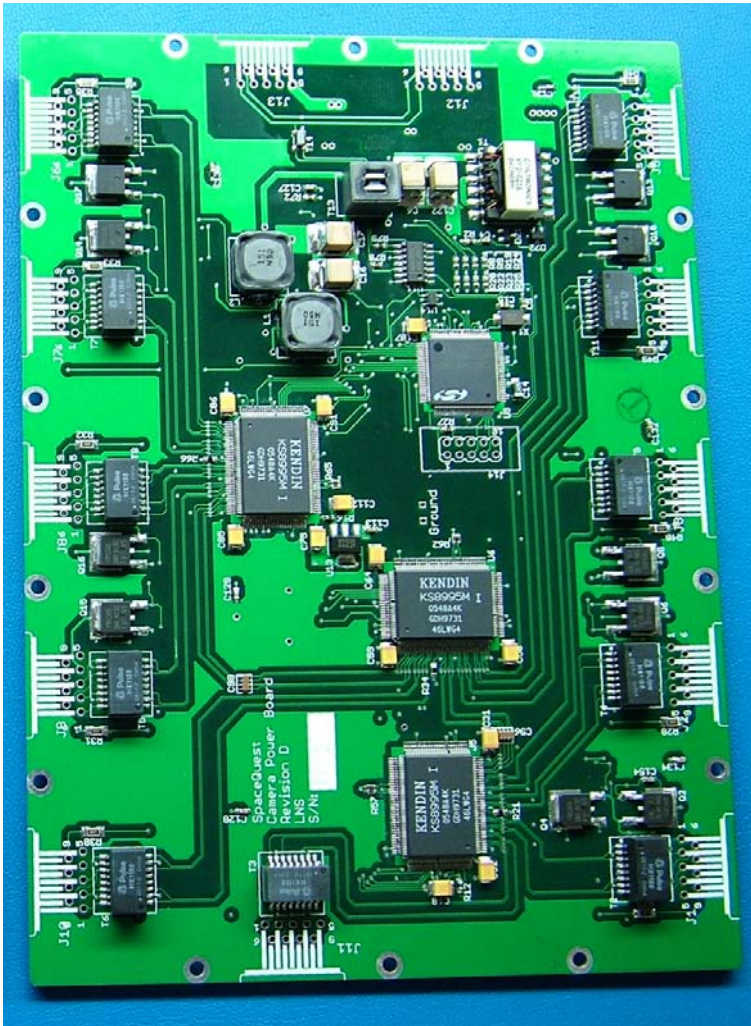


Power Conversion Distiller

- SIF-compatible chassis holds power conversion cards
- Digital telemetry and command with PMbus
- “Fractions”
 - High current H-bridge
 - Dual DC/DC converter
- Overcomes power system paradox:
 - First needed for integration
 - Last to receive requirements



11 Port Ethernet Switch



- 11 ports, 100 Mbps
- 10 Switched +28 V outputs
- 1-Wire[®] telemetry network
- Complete management and diagnostics over CANopen

Lessons Learned

- A standard interface will pay off, even over the course of a single satellite
 - The second satellite is even easier
- Use of industry standards is worthwhile, even if no COTS equipment is used
 - Others have already found and fixed the “gotchas”.

Availability

- SIF is an open standard, free for all to use.
- Full specification details in the paper
- Please consider using SIF when:
 - Designing a new widget
 - Designing a new satellite bus
- SIF has proven its engineering advantages
- Who knows how far it can take us as a collaborative tool?