Low Speed Multidrop Busses - New Architectures Enabled by All-Digital Low Speed Sensor Networks

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On board transducer networks, part of a strategy.

The needs.

On board transducer networks are part of a long haul strategy shared between ESA and the European industry, and which aims for the development of efficient spacecraft architecture solutions.

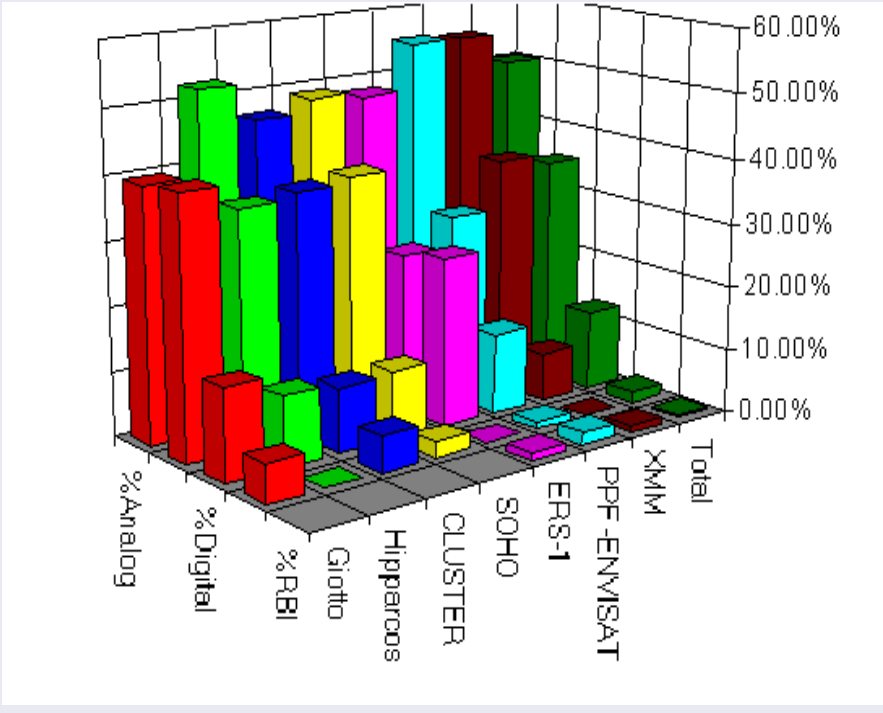
What for.

Digital and mixed ASIC technology has allowed concentration of functions that once were distributed on multiple PCBs on a single component. As a matter of fact size (and RELIABILITY!) of SCUs is sometimes constrained by number of connectors more than number of functions.

Discrete sensors and discrete lines

Some numbers:

Discrete sensors seem to be unavoidable in all systems. Moreover, their number is growing, due to the growing peripheral intelligence. But looking at their functions we discover that most of them are only simple thermistors...



The Architecture

Context

In the context of spacecraft sub systems evolution and global spacecraft architecture efficiency strategy, there is an increasing need for data networks.

What the future will bring

At esa we see future spacecrafts on board communications based on safe digital serial busses, bridged to allow interoperability

The Architecture (2)

ESA's strategy

ESA has been developing a strategy towards the adoption by European space industry of a common standard for point to point interfaces.
The concept of sensor network is a good candidate to transform discrete interfaces into bus ones, providing that a proof of concept and an in depth analysis of the consequences at system level due to the introduction of such technology in a spacecraft is done.

What do we have already

Command & Control

MIL-STD-1553 has been used for a decade now in European spacecrafts. The amount of know how in European industry is such that is easy to foresee still a long future for it

CAN bus is getting momentum, since it overcomes many of the limitations of MIL-1553, allowing low power RTs, use of cheap COTS EGSE, and solid development methods.

Fast Links

Spacewire is already the workhorse for fast point to point links. With the availability of the router and SpWRTC ASICs may even get into C&C.

How this is mapped in ECSS

ECSS-E50-09 (draft)

will sit on top of BOSCH CAN 2.0 specs narrowing them down for space use, and defining missing items.

ECSS-E50-13 (in public review)

will sit on top of MIL-STD-1553B reducing designer's degrees of freedom, thus finally allowing interoperability.

ECSS-E50-11/12

Specify Spacewire and RMAP protocol

ECSS-E50-14

Part A (published) has finally frozen the spec for the analog point to point interfaces and "modern" TTC-B-01 interfaces. Part B will define the standard for low speed transducer bus

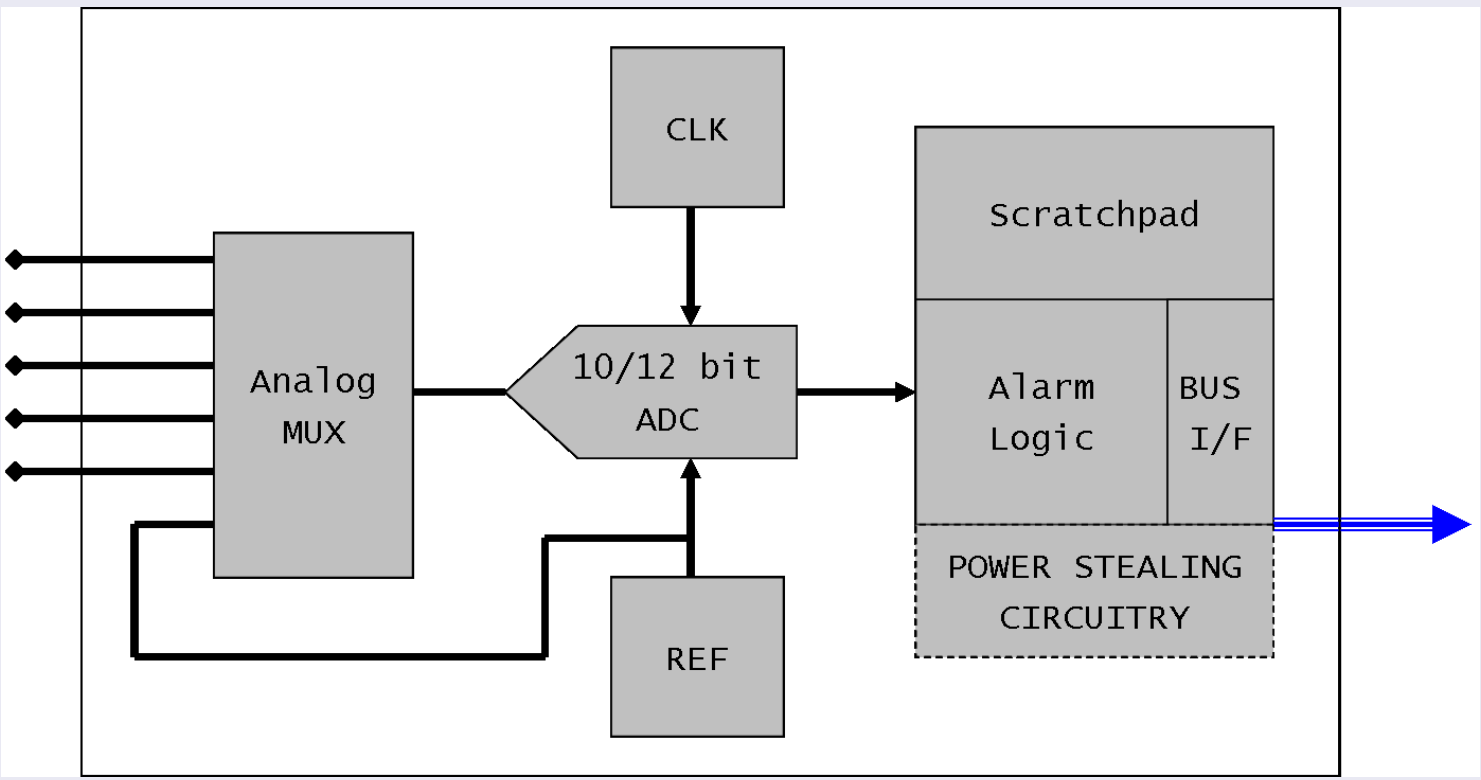
What do we need

A low speed ($\sim$ kbps) digital network with:

- 100s of addressable sensors on a single line
- single Twisted Pair
- $\sim$ 10m of branch length
- Self powering
  If the transducer IF is capable of self powering from the data network this will allow to have single chip transducers, in nice SOT3 packages.

The Proposed Architecture

A single chip intelligent transducer



The possible gains

In the context of spacecraft architecture optimisation, sensor networks are a good candidate for the optimisation of point to point interfaces, which are numerous: The vast majority of the interfaces (98%) in a spacecraft are to simple sensors and actuators using analogue or discrete digital interfaces.

The possible gains (2)

By examining terrestrial developments in automotive, process control, and computing, it is possible to argue that sensor bus technologies could offer significant benefits in terms of easier system testing and integration, an increased potential for component re-use, and the possibility of sourcing components from different suppliers.
Sensor network concept has promising capabilities for space use, with the ultimate objective of reducing the harness through a significant decrease of the amount of point to point interfaces.

But is not only to save some mass...

Additional capabilities

- Standardization
  - Unique SW layer
  - Simpler acquisition architecture ("*pull*" instead of "*push*")
  - Use of same set of sensors in flight and in AIT/V
  - Dramatic symplification of EGSE
  - Take away analog lines from the harness (solves EMI issues).
- Industrial Edge
  - A big step towards complete platform reuse - Allows flexible dimensioning of the I/Os
  - Dynamic device discovery capability
  - Synergies with other powerful European domains like avionic and automotive

It is not just chat

Activities at ESA

- Spin in from other domains
  - Test and characterization of I2C, 1-wire, LIN, SPI
  - Total dose test of COTS single chip sensors
  - A self contained temperature logger
- Long term research
  - **2 TRPs** ongoing for evaluation of digital sensor bus technology candidate
  - The idea is to
    - Avoid reinventing the wheel
    - Start standardization (ECSS-E50-14B) ASAP

RESULTS SOON!

Summary and Conclusions

- Technology spin-in from other domains.
  - Space may gain a lot from that
- Slow (kbps) multidrop bus.
- One single harness allows connection of 100s of transducers/actuators of different type.
- Dynamic network discovery capabilities (aka Plug'n Play).
- Data over power network (or power on data link) solution for simple units/SOC (like USB).
- Simplifies software
- Reduces harness
- Increases reliability