

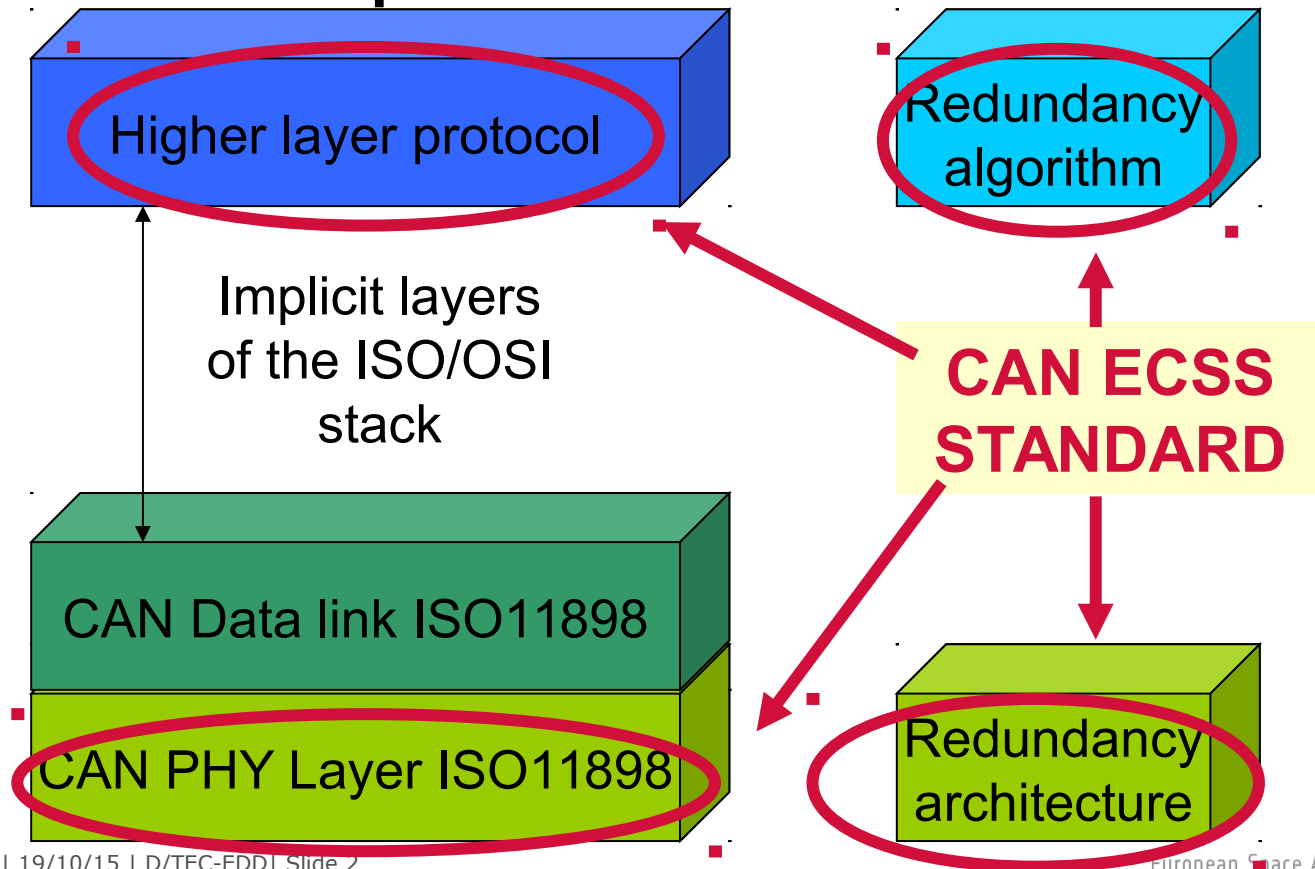
***CAN IN SPACE  
STATUS AND FUTURE AFTER  
ECSS-E-ST-50-15C RELEASE***

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**ECSS-E-ST-50-15C has been published.**

**This is the tool that you need to start your CAN in space implementation.**



# ***CAN & Space, who's rotten idea is this ?***



- **September 27, 2003 ESA launched SMART-1 mission, that used CAN as unique C&C bus.**
  - It worked spotlessly until mission planned crash on moon surface on Sept 3, 2006.
- **Use of CAN as payload bus picked up in non-systematic way in latest years**
  - In payloads heritage is less important
  - Keeping payload and platform bus separate is sometimes convenient
- **Development of Exomars and ECSS standard (2009 - ...) has followed this process**
- **CAN is now baselined to be used in future Telecom and EO platforms & payloads**

## Main CAN advantages

- **Very robust error detection and correction mechanisms**
- **Low cost**
- **Low power consumption**
- **Inherently multi-master**
- **European technology available**
- **Widely used and validated in terrestrial applications**

## Main CAN drawbacks

- **Latency jitter is bus-load dependent**
- **Bus redundancy not part of the ISO standard**
- **Availability of components for high radiation dose tolerance**
- **Lack of standard galvanic isolation**

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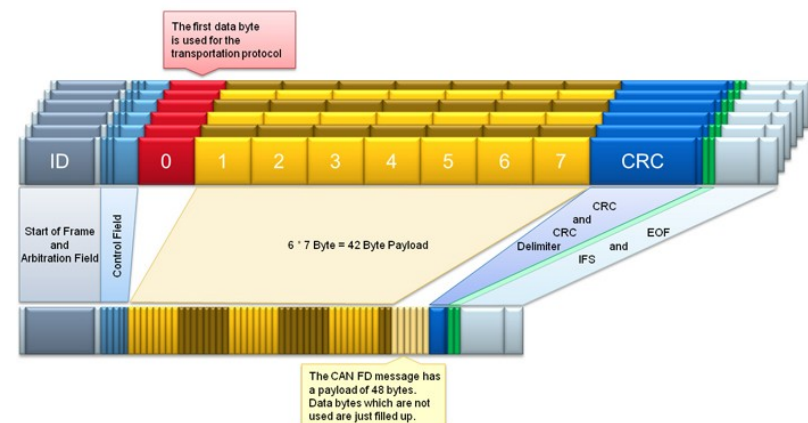
**Availability of components for high radiation dose tolerance**

- **Lack of standard galvanic isolation – *is it really so important ?***

- **Is 1Mbps enough in 2015 ?**
  - Secure transmission is possible at a maximum rate of 1 Mbps.
  - The maximum data rate at VOLKSWAGEN and AUDI (*excluding special test software*) has been fixed at 500 kbps, other manufacturers have even less.
  - In cars, the CAN bus system is divided into (at least) 3 special systems due to the different requirements regarding signal repetition rate and the large data volume:
    - Drive train CAN bus (high-speed) at 500 kbps with almost real time requirements
    - Convenience CAN bus (low-speed) at 100 kbps with low timing requirements
    - Infotainment CAN bus (low-speed) at 100 kbps with low timing requirements

- **Will 1Mbps be enough in 2035 ?**
  - Old generation telecom payload busses support 32 subscribers at 16kbps.
  - “Horizontal” data distribution and data push schemes help in keeping data throughput very efficient
  - High signal rate is mostly required by time distribution or low latency requirements rather than high data throughput on command and control system
- **CAN has demonstrated in past ~ 30 years to be a very resilient communication standard.**
  - It will be likely thrive rather than fade out with the advent of e-mobility
  - All e-bikes mount CAN hardware !

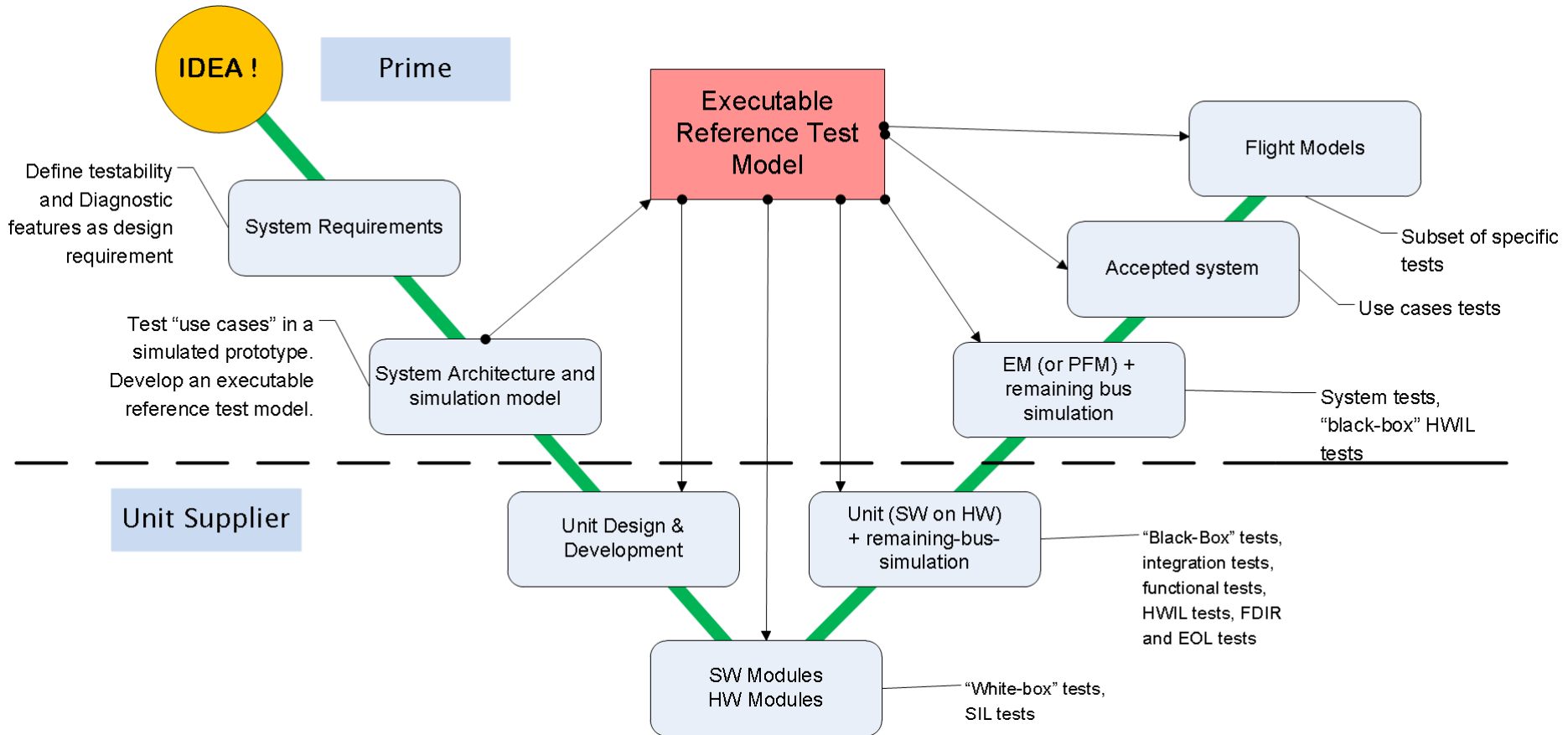
- For e-cars industry is (gradually) moving towards CAN-FD
  - Improves CAN in two ways:
    - support of bit rates  $> 1$  Mbit/s
    - support of payloads  $> 8$  byte per frame
  - Needs new phy (we have already one qual transceiver supporting it)
  - Allows full reuse of SW and tools





- **Do we have all the toolbox for CAN in space ?**
  - Physical layer
    - ECSS foresees use of ISO Transceivers
    - Other PHY (including wireless, optical) not qualified yet
    - RS-485 (referenced in ECSS) shall be considered as a legacy solution
    - If Redundancy is implemented, it shall be as described in ECSS
  - Protocol layer
    - No protocol is a protocol
    - But in any case you will need a redundancy management scheme
    - CANOpen provides all the services for redundancy management and much more
  - SW & development tools
    - Electronic Data Sheets are a key here ... provided by CANOpen
- **Is Design for testability a (sufficient) push ?**

# CANOpen-based testability design cycle



- **THREE** major IC companies are planning very soon release of 3.3V QML ISO CAN transceivers, rad hard.
  - Intersil has prototypes available
  - Texas Instruments has prototypes available
  - Aeroflex has prototypes available
  
  - You can contact me or them to get more information on all the above
- **ESA has patented (and tested) a DARE library extension for rad-hard CAN I/O for MS-ASICs**
- **ISO CAN transceivers will be flying on telecom missions as early as 2017.**

# **Protocol Layer: what can CANOpen do for me ?**



- **CANOpen provides a set of useful services for avionics**
  - Event driven communication
  - Synchronous and Isochronous cyclic communication
  - Error management
  - Determinism (if needed)
  - Master-Slave model for management
  - Server-subscriber model for configuration (SDO)
  - Producer-consumer model for distributed control (PDO)
  - EDS (electronic data sheets), standardized (CiA)
    - With conformance and testing tools !
- **ECSS-E-ST-50-15C disciplines use of CANOpen for space applications**

- **The use of CAN with CANopen based higher layers leads to cost efficient and flexible solutions, but together with an increase of the electronics' complexity.**
- **Big complication for space systems is the typical approach of distributed development between primes and several suppliers.**
- **The consequence has to be a systematic improvement of the development process.**
- **Project risks are to be reduced by taking testability as a design requirement and by performing the appropriate tests in the very early project phases.**

- **ECSS CAN will be accompanied by an implementation handbook.**
- **We still miss a comprehensive validation test plan for ECSS CAN, even if we can inherit from commercial ones**
  - ISO 16845:2004 CAN - Conformance test plan
  - CANopen conformance test tool from CiA
- **Nevertheless, SAE VTPs (AS411x) for 1553 failed to educate industry to the 'early testing' habit.**
  - VTPs are often waived for recurrent units, missing the whole point behind them
- **In ESA we soon plan to gain experience on CANOpen-based testability design cycle. Stay Tuned.**

- **One of the huge advantages of an higher level protocol is a guarantee of interchangeability between the same type of off-the-shelf devices that comply with this networking standard, thus simplifying the task of system integration.**
- **Industrial machine control is exploiting this incorporating additional specification and standards which cover device/function specific aspects of a CANOpen implementation**
- **The documents that constitute the CANOpen Device Profiles describe, in detail, how to use CANOpen for a particular type of device, what communication parameters are available, and how the Obj Dictionary is set up.**

See you at '**CAN IN SPACE WORKSHOP**'

Here 10<sup>th</sup> of March 2016

<https://indico.esa.int/indico/event/120/>

<https://goo.gl/kSnXMu>

