

WE LOOK AFTER THE EARTH BEAT

Zwischenpräsentation

Reliable high-speed data transfers on satellites across Wizard-Link

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19/11/15

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/// Motivation

/// Radiation Effects

/// Error Control

/// Existing High Speed Links

/// WizardLink

/// Further radiation analysis

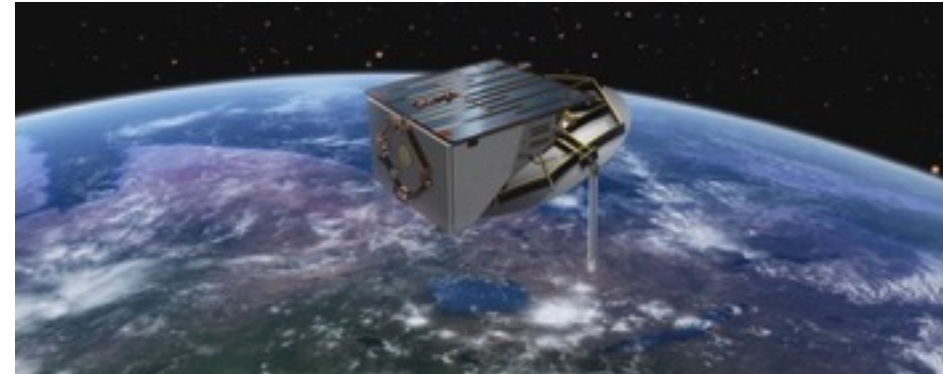
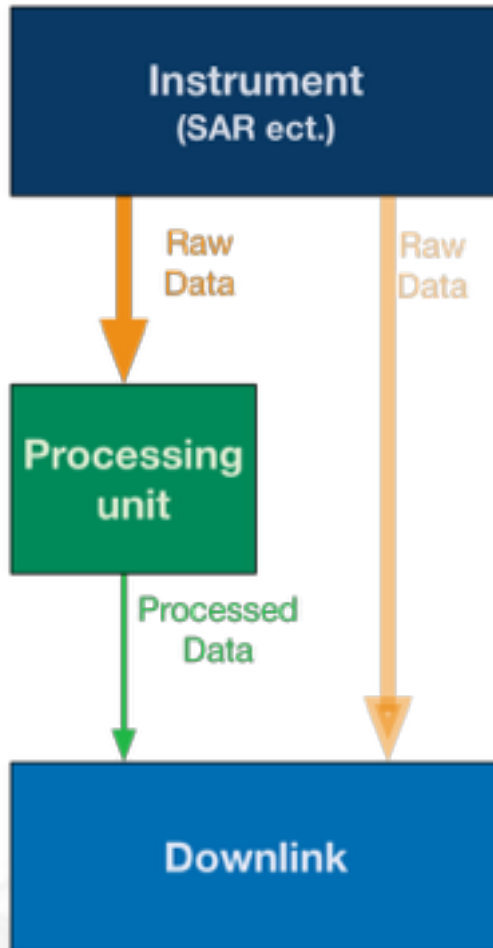
/// Next Steps

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SARah,
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Sentinel-1,
©ESA

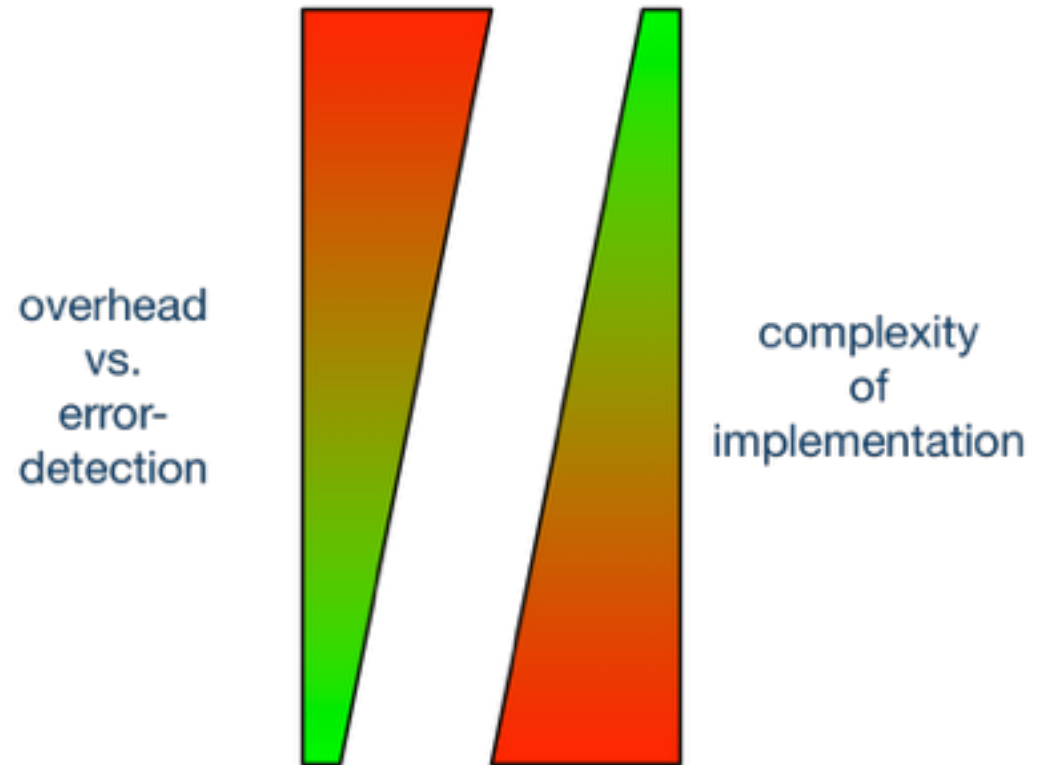
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- reliable high-speed data transfer protocol for Space
 - based on Wizard Link (PHY)
 - high reliability
 - minimal overhead & low latency
 - small footprint
 - covering only OSI Layer 1 & 2

- /// Total Ionizing Dose (TID)
 - /// cumulative damage (rads)
 - /// leakage current and threshold shifts
- /// Single Event Effects (SEE)
 - /// Single Event Latch-up (SEL)
 - /// Single Event Multiple Upset (SEMU)
 - /// **Single Event Upset (SEU)**

[1] from presentation "Radiation Models and Hardware Design" Some, Raphael

- Repetition codes
- Parity Bits
- Checksums
- Cyclic Redundancy Check
- Others:
 - Error correcting codes

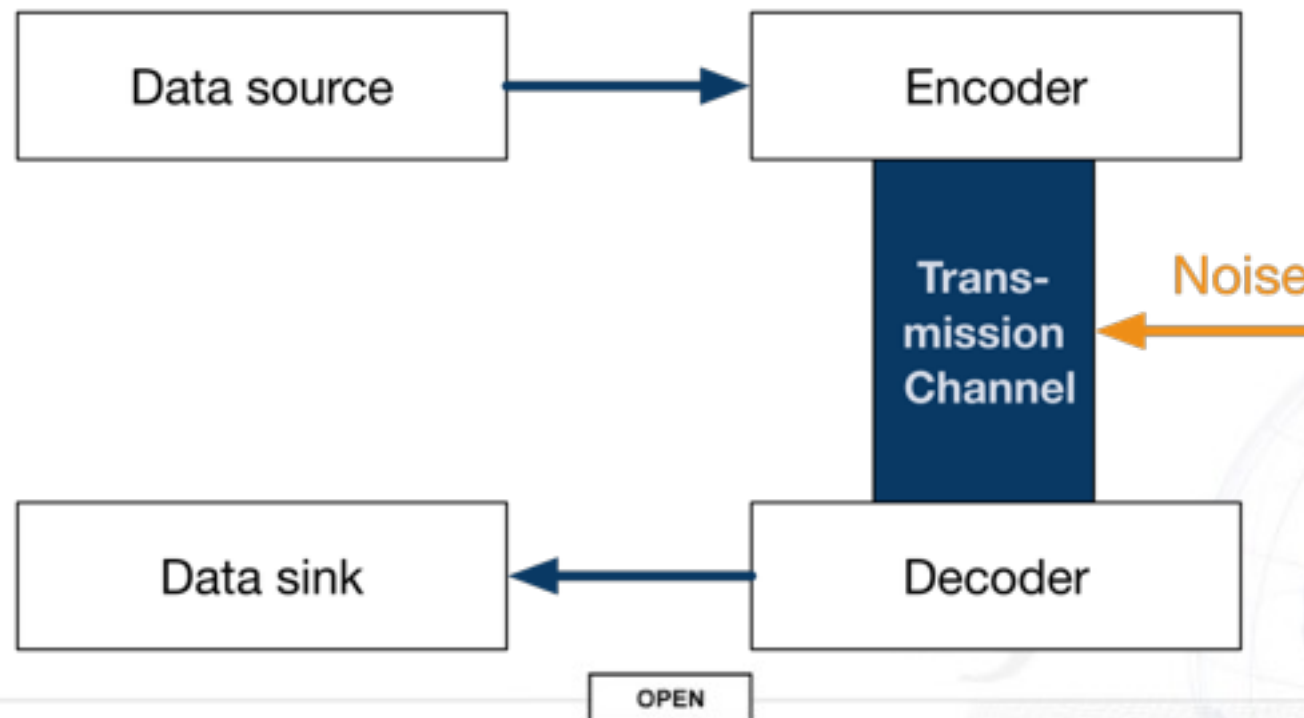


idea: increased Hamming Distance via encoding

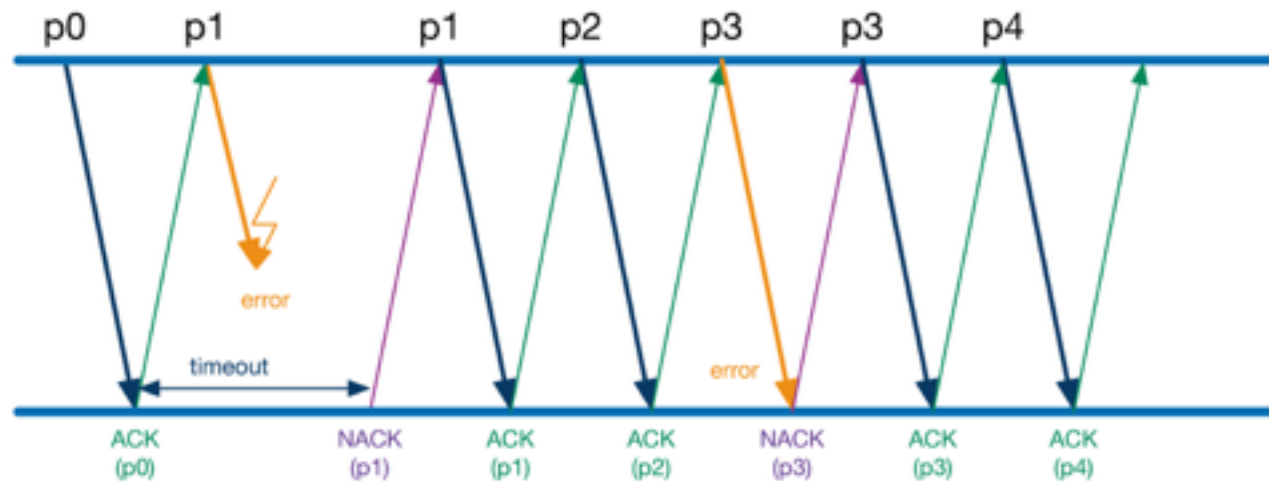
better "Signal-to-Noise Ratio"

block codes

convolutional codes



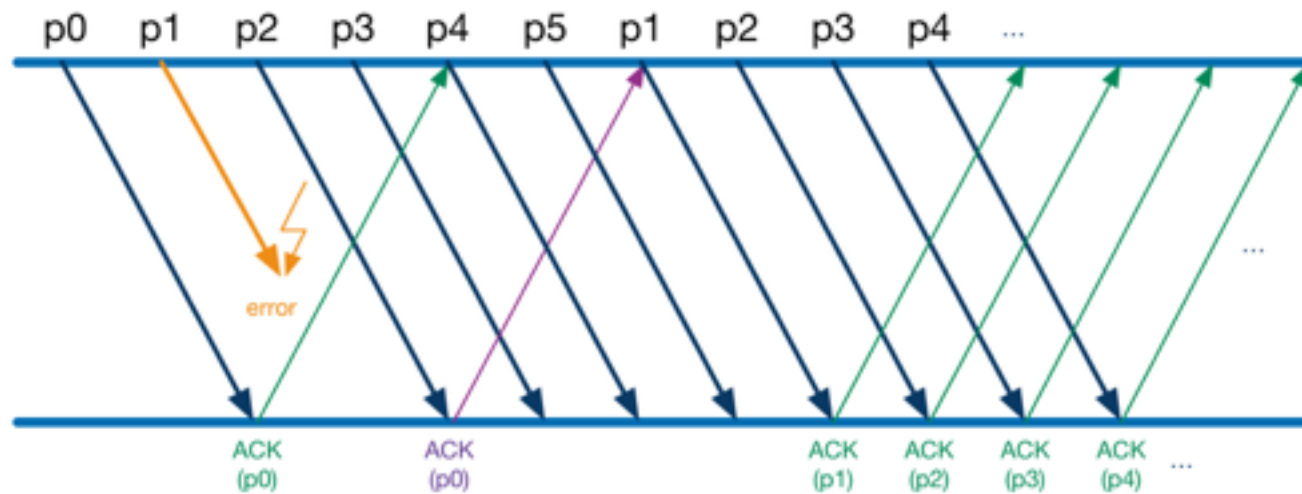
Stop-and-Wait:



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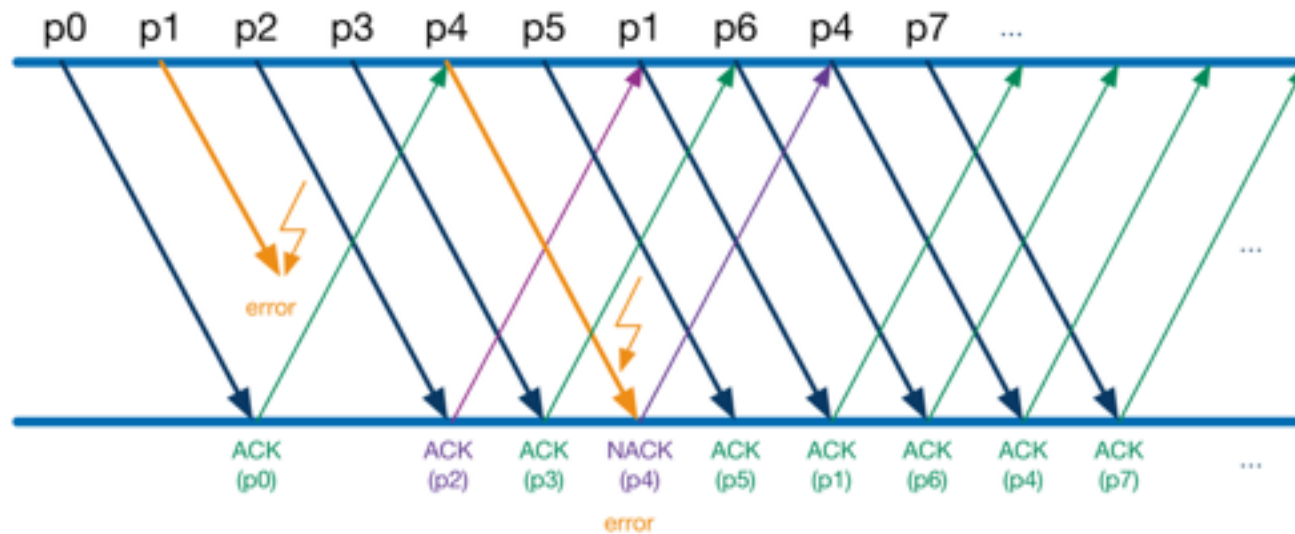
Stop-and-Wait

Go-back-N:



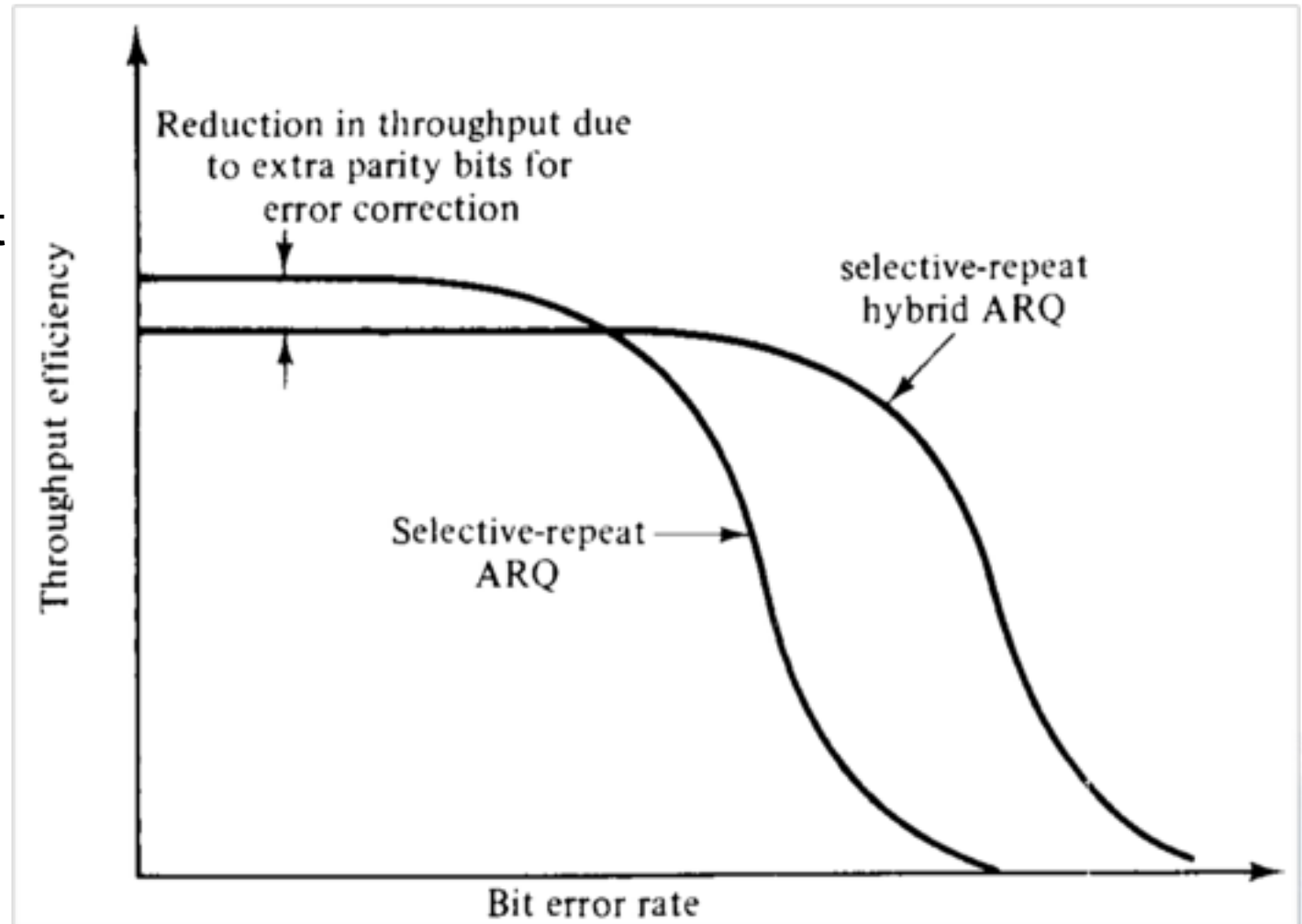
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- Stop-and-Wait
- Go-back-N
- Selective repeat:



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- Stop-and-Wait
- Go-back-N
- Selective repeat
- Hybrid ARQ:



Normal ARQ vs. Hybrid ARQ,

modified, from Error Control Coding Fundamentals and Applications - Shu Lin Fig. 15.14

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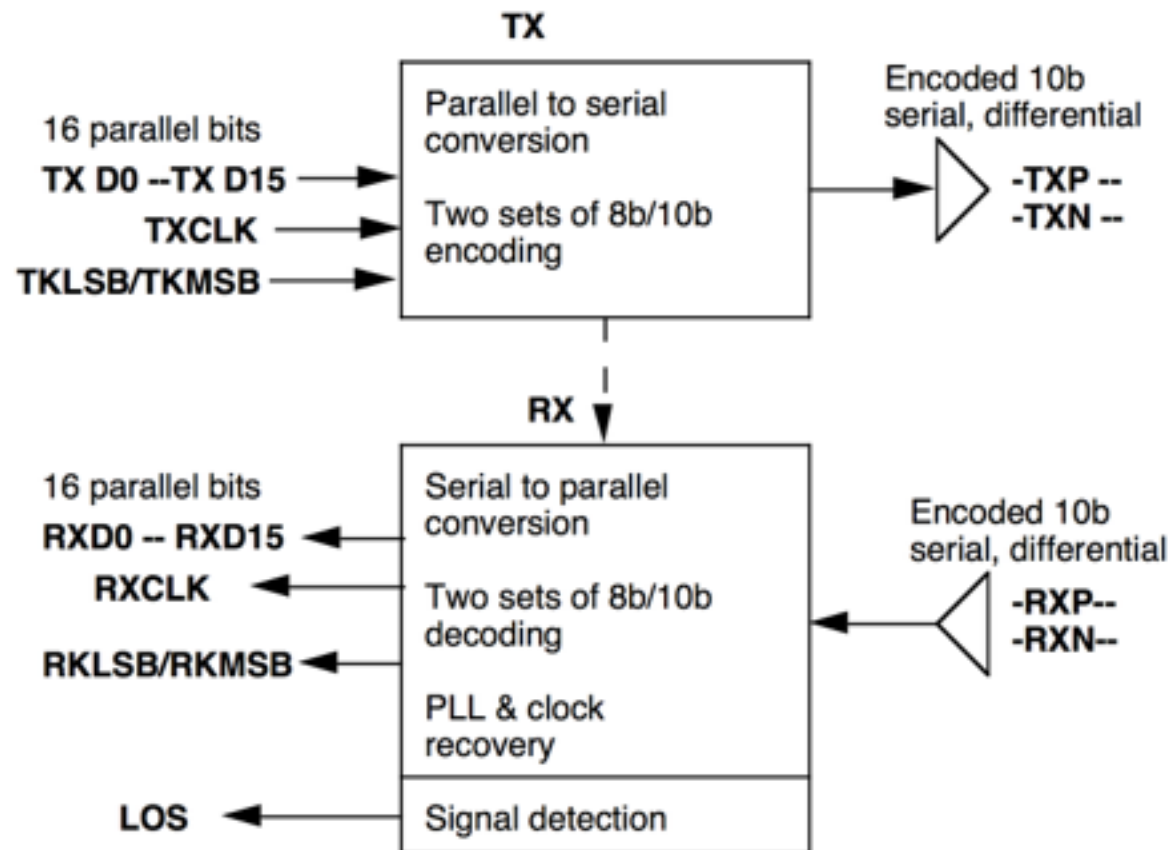
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Link	OSI Layers	Space Heritage	Failure Detection	ARQ Scheme	max. dist. via copper
<i>SpaceFibre</i>	1, 2, 3, 4	planned	16-Bit CRC	modified Go-Back-N	10m
<i>RapidIO</i>	1, 2, 3, 4	yes	16-Bit CRC	Go-Back-N	10m typ.
<i>Gigabit Ethernet</i>	1, 2	little	32-Bit CRC	none	25m/100m
<i>PCIe</i>	1, 2, 3	little	32-Bit CRC	Stop-and-wait	1m - 7+m
<i>USB (3.0)</i>	1, 2, 3, 4, ...	very little	16-Bit CRC	Stop-and-wait	3m
<i>SATA</i>	1, 2, 3, 4, ...	very little	32-Bit CRC	none	1m
TLK2711	1	yes	no	none	10m



- family of multigigabit transceivers by Texas Instruments
- TLK2711 — 16-Bit SERDES
 - 8B/10B encoding
 - LOS-Detection
- available as MIL-Grade (-SP)
 - temperature hardend
 - quality controlled
 - vibration resistant





Additional Lines:

RX receiving signals directly (without serializing) from TX (LOOPEN), pseudo random bit stream (PRBS) testing (PRBSEN), & other control lines for special k characters, etc.

TLK 2711-SP Block Diagram

from "Single Event Effects and Total Dose Test Results for TI TLK2711 Transceiver" Fig. 1

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research from Koga, R. et. al. [1] :

Bit errors — 1-3 bits — when registers get hit

Burst errors — 100-1000 bits — when PLL ect. get hit

Latch-Up-Immune

no major bias current change at 140 kRad TID

[1] “Single Event Effects and Total Dose Test Results for TI TLK2711 Transceiver”

Koga, R. ; Yu, P. ; George, J., In: Radiation Effects Data Workshop, 2008 IEEE, 2008, S. 69–75

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speculative Orbit:

1400km Ap.; 98° Inc.; 0° Arg. Pe.; Circular

7 years mission time; launch 01.01.2017

Radiation Model AP8, CREME96,

geoshielding, quite magnetosphere

Results:

avg. **Bit** Errors: 3.4 Upsets/day

avg. **Burst** Errors: 7.2 Upsets/day

- measure:
 - time to sync, recovery from LOS
 - behaviour near LOS

- decide on:
 - flow control symbols
 - packet size
 - Layer 2 error control scheme
 - Hybrid or normal ARQ
 - which scheme

- implement and test

- Book: **“Error Control Coding Fundamentals and Applications”** - Shu Lin et. al.
- **“TLK2711-SP 1.6-Gbps to 2.5-Gbps Class V Transceiver”**. Texas Instruments datasheet, last revised Oct.2014, . – see <http://www.ti.com/lit/ds/symlink/tlk2711-sp.pdf>
- **“Radiation Models and Hard- ware Design”** Some, Raphael, presentation in 2002, 2002. – see <http://webhost.laas.fr/TSF/IFIPWG/Workshops&Meetings/44/W2/02-Some.pdf>
- **“Single Event Effects and Total Dose Test Results for TI TLK2711 Transceiver”**
Koga, R. ; Yu, P. ; George, J., In: Radiation Effects Data Workshop, 2008 IEEE, 2008, S. 69–75

used in serial transmissions

DC-Balance

limit on successive '1's / '0's

clock recovery

data symbols (8 bit data → 10 bit encoded)

K-Chars

byte alignment

control symbols

7	Application
6	Presentation
5	Session
4	Transport
3	Network
2	Data Link
1	Physical

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