

超可靠高速存储与通信:高强度纠错码

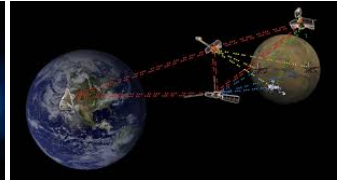
Ultra High Reliable, High Speed Storage & Communication: Powerful Error Control Coding (高可靠、高速存储与通信:高强度纠错码)



Flash Storage
(Flash 存储)



Fibre-Optic Communication
(光纤通信)



Deep-Space Communication
(深空通信)

Common and Distinct Requirements (共性需求与个性需求)

Flash Storage

- **Low Cost:** Massive Usage
- **Ultra High Reliability:** $\leq 10^{-15}$
- **High Speed** Encoding and Decoding: $\sim 7\text{Gbps}$
- **Low-Latency:** $\sim 3\mu\text{s}$
- **High Performance:** 1~2dB to Shannon Limit

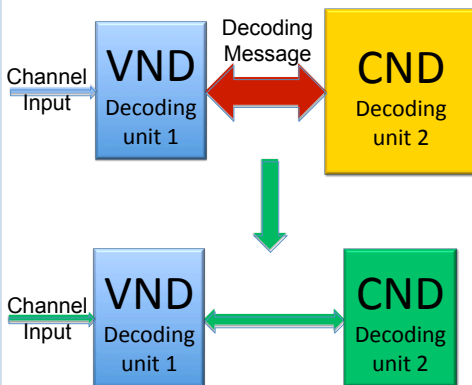
Long Haul & Data Centre Fibre-Optic Link

- **Ultra High Reliability:** $\leq 10^{-15}$
- **Ultra High Speed** Encoding and Decoding: 100~400Gbps
- **Low-Latency:** $\leq 5\mu\text{s}$
- **Ultra High Performance:** $\geq 9\text{dB}$ Net Coding Gain

Deep-Space Communication

- **High Reliability:** $\leq 10^{-12}$
- **Ultra High Performance:** $\leq 1\text{dB}$ to Shannon Limit

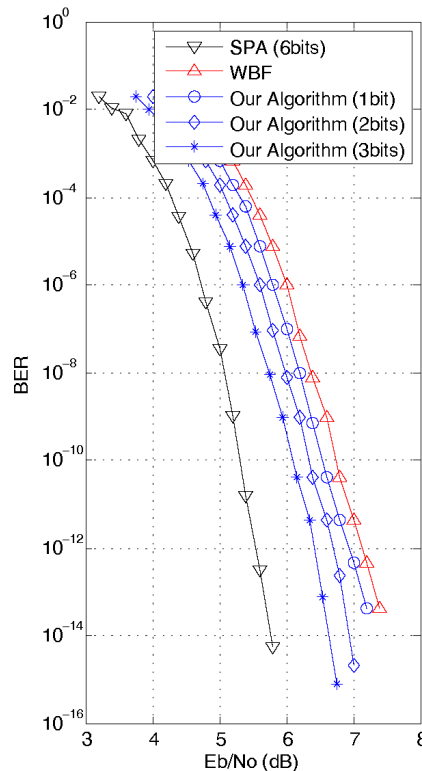
Low Complexity & High Speed (低复杂度、高速)



- **Flexible Channel Input:** Hard-decision information or soft-decision information compatible (**Very suitable for Flash storage:** One decoder for all lifetime)
- **Reduced Decoding Message:** From conventional 6 bits information to 1-3 bits information (**Very suitable for high speed application:** full parallel decoding is possible)
- **Simplified CND Decoding Algorithm:** Can be implemented in combinatorial logic gate or simple look-up-table

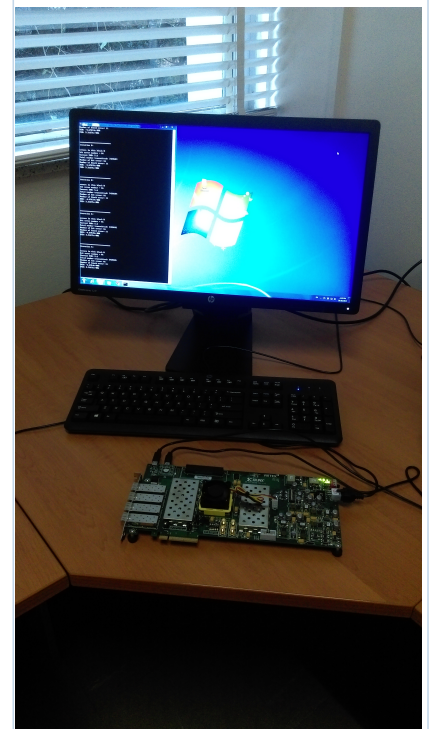
Code length	1KByte
Code rate	0.93
Slices (virtex-7)	18921
36kb RAM	56
Clock frequency	300MHz
Throughput	$\sim 7\text{Gbps}$

Ultra High Reliability & Ultra High Performance (极高可靠性)



- **No error floor to 10^{-15}**
- **Only $\sim 0.6\text{dB}$ away from Full message decoding with low complexity decoding**

Hardware Validated (经过硬件验证)



- **Implemented on Xilinx Virtex-7 FPGA**
- **More than 3×10^{16} bits are transmitted and decoded**

Error control in Flash storage system (Flash Array, Flash Disk),
Error control in Fibre-optical link (long-haul backbone,
interconnect between racks in data centre),
Error control in deep-space communication

Flash存储系统纠错(固态硬盘、Flash阵列),
光纤传输系统纠错(骨干网光纤传输、
数据中心机架之间的连接),
深空通信系统纠错