Present Status of Solid State Mass Memories and near Future Needs

EADS Astrium and IDA TU Braunschweig

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Mass Memory Product Applications (1)
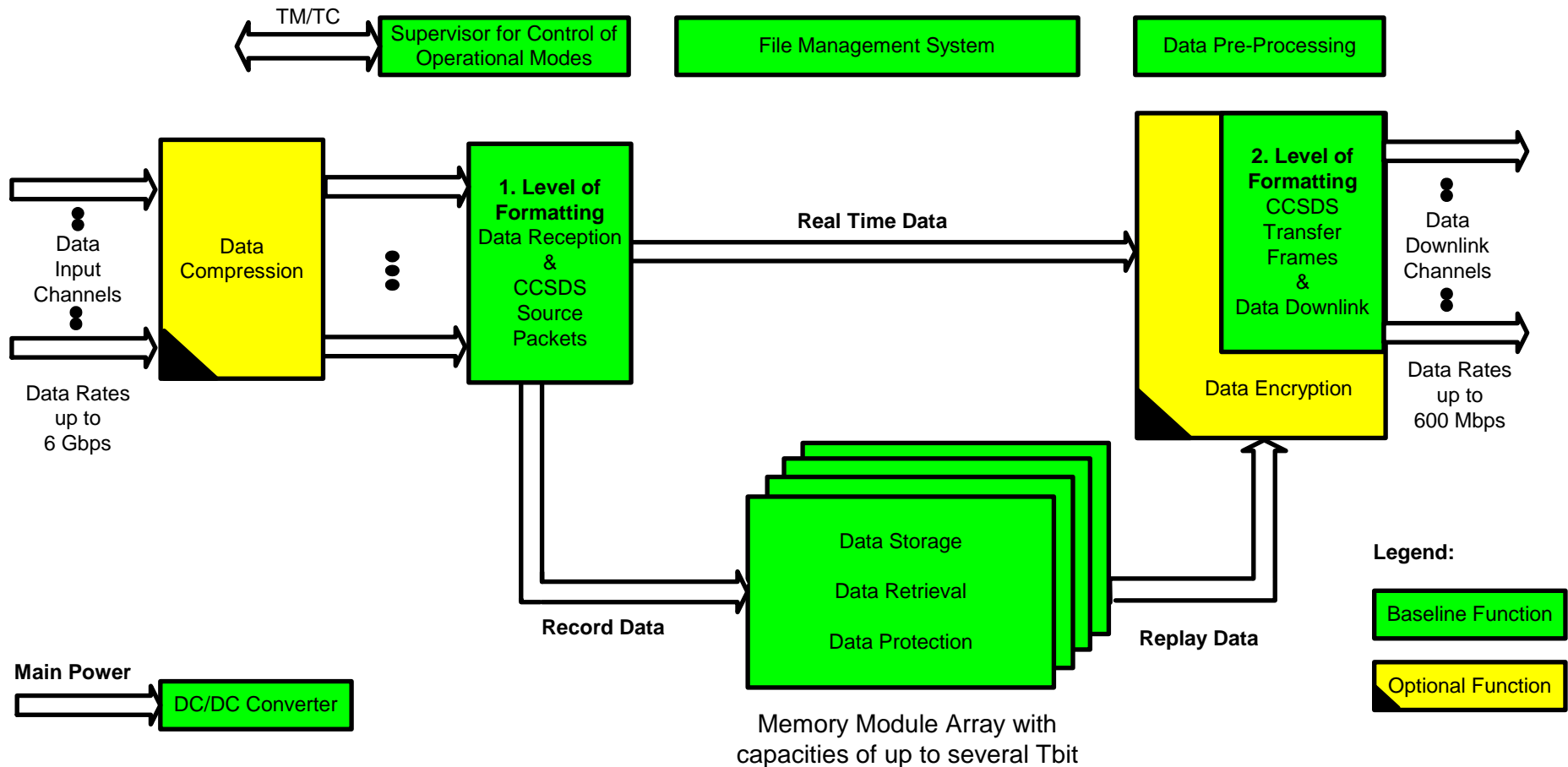

TerraSAR-X – Mass Memory Unit

Integrated Solid State Recorder "ISSR"

Missions with need for data storage and retrieval of:

- **Optical Instrument Data**
- **Radar Instrument Data**
- **Science Instrument Data**
- **Spacecraft System and Health Data**

Mass Memory Product Applications (2)

Mass Memory Functional Block Diagram

TM/TC

Supervisor for Control of Operational Modes

File Management System

Data Pre-Processing

Data Input Channels

Data Compression

1. Level of Formatting
Data Reception & CCSDS Source Packets

Real Time Data

2. Level of Formatting
CCSDS Transfer Frames & Data Downlink

Data Downlink Channels

Data Rates up to 6 Gbps

Data Encryption

Data Rates up to 600 Mbps

Record Data

Data Storage

Data Retrieval

Data Protection

Replay Data

Main Power

DC/DC Converter

Memory Module Array with capacities of up to several Tbit

Legend:

Baseline Function

Optional Function

# Optional Functions

Data Compression

- Data compression may be an integral part of the Mass Memory or may be a separate function / unit (depending on data rate , No. of data channels and mainly due to size and power consumption)

- Data compression is used for EO missions (SAR images or optical images)

- Performance parameter for data compression (lossless and lossy compression)
  - Data rates up to 45 Mpixel/s per channel
  - Up to 16 individual data channels can be processed simultaneously
  - Various compression algorithms e.g. JPEG, WAVELET, CCSDS-BPE

Data Encryption

- Very high data rate encryption for X-Band data downlink (up to 600 Mbps) as integral part of the Mass Memory Unit

- Implementation of various encryption algorithms, e.g. Triple DES and/or proprietary encryption block algorithm

Mass Memory Product Heritage

20 years of Flight Heritage without Interruption
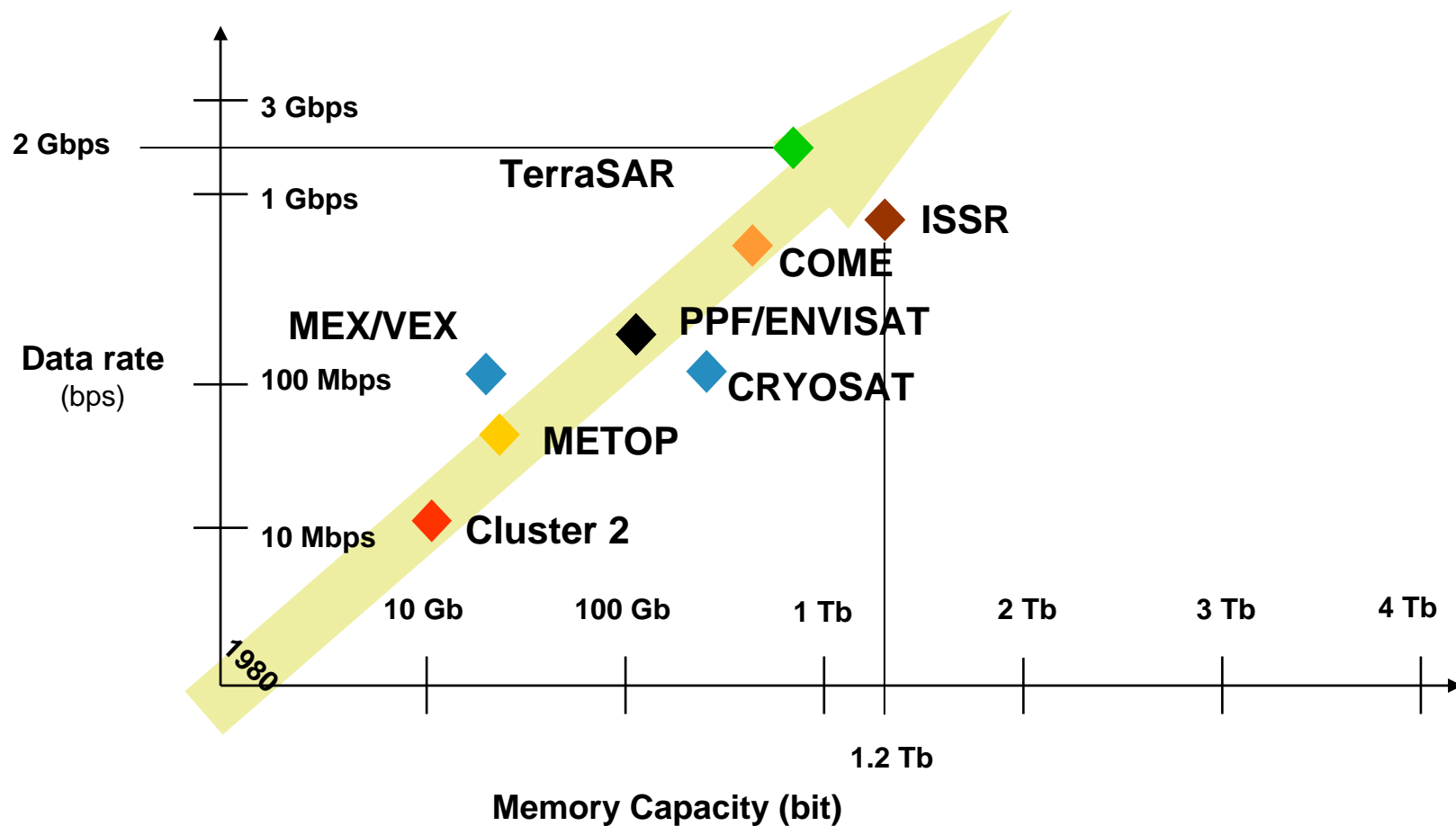
Market Needs & Future Mass Memory Developments

- Request for large Mass Memory Capacities (several Tb) and need for new Double Data Rate SDRAM (DDR 1/2/3) Generation
  (512 Mb SDR-SDRAM technology obsolete since 2004 several thousand of 512 Mb SDRAM's available from Astrium stock)

- Request for higher Data Rates and need for Very High Speed Mass Memories (e.g. several Gbps)

- Need for a new Memory Module design incorporating the state of the art DDR 1/2/3 SDRAM technology and real time error correction codes (baseline Reed Solomon) tailored to the failure mechanism(s) of the DDR 1/2/3 SDRAM technology

- Request for Non-Volatile Mass Memory: New Generation of Non-Volatile Memory (FLASH) Keyword: Safeguard Data Recorder (SGDR)

- Need for improvement of:
  - File Management System (FMS)
  - Compression (different and high speed algorithms)
  - Encryption (different and high speed algorithms)
  - Formatting (different and high speed standards)

- Very high Speed Interface links

Need for Future Mass Memory Developments

- Evaluation (radiation and electrical) of "state of the art" DDR 1/2/3 SDRAM memory devices

- Design and Development of a new Memory Module based on DDR 1/2/3 SDRAM technology

- Future Mass Memory Architecture to cope with high data rates and large capacity requirements

- Embedded very high speed Error-Correction methods (advanced RS-code)

- Preparation of DDR 1/2/3 SDRAM procurement specification

- Qualification of FPBGA assembly process and lead free soldering methods

- Need for low voltage (1.8/1.5 V) design methods, interface circuits and decentralised supply networks (decentralised DC/DC converters)

- New high speed and low voltage design methods and high speed interface links

- Need for advanced board level and housing level cooling methods (> 30 W per single board; > 200 W for a complete unit). Keywords: mini heat pipes; mini loop heat pipes

Mass Memory Development Roadmap

	Generation 1 SSMM Now 2004 to 2006	Generation 1 High Speed SSMM Now 2004 to 2006	Generation 2 Mid-Term 2006 to 2008
Market & Applications			
	ISSR	TerraSAR-X-SSMM	Sentinel 1;2;3
	CryoSat MMFU	Tandem X -SSMM	
Key Features			
Capacity	600 to 1.300 Gbits		> 5 TBits
Data Rate	800 Mbps to 1.5 Gbps		> 3 Gbps
Mass	15 kg to 30 kg		30 kg to 50 kg
Power	60 W to 130 W		130 W to 200 W
Key Technologies			
Memory Components	SDRAM 512 Mbits		DDR 1/2/3 512 Mb / 1 Gbit
Package / Module	TSOP/cubes		FPBGA / cubes
Board level interconnections	Parallel bus (300 Mbps)	Serial link (1.1 Gbps)	Serial links (up to 6 Gbps)
Thermal management	Standard boards and passive cooling 15 W/board; 130 W/unit		Advanced active cooling 30W /board; 200 W /unit.
Equipment level interconnections	High Speed parallel link /bus (800 Mbps)	High Speed Serial links (1.1 Gbps)	Very High Speed Serial links (2...6 Gbps)

History of Memory Devices

Mass Memories Technology Support Program
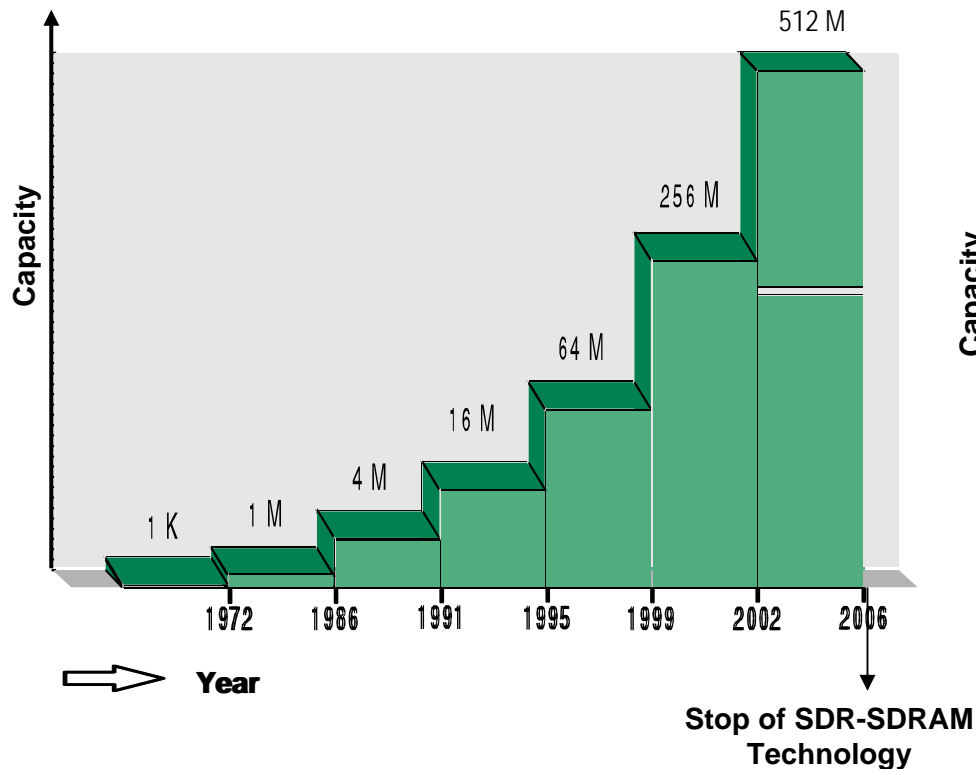
Evolution of the SDR-DRAM Memory Technology
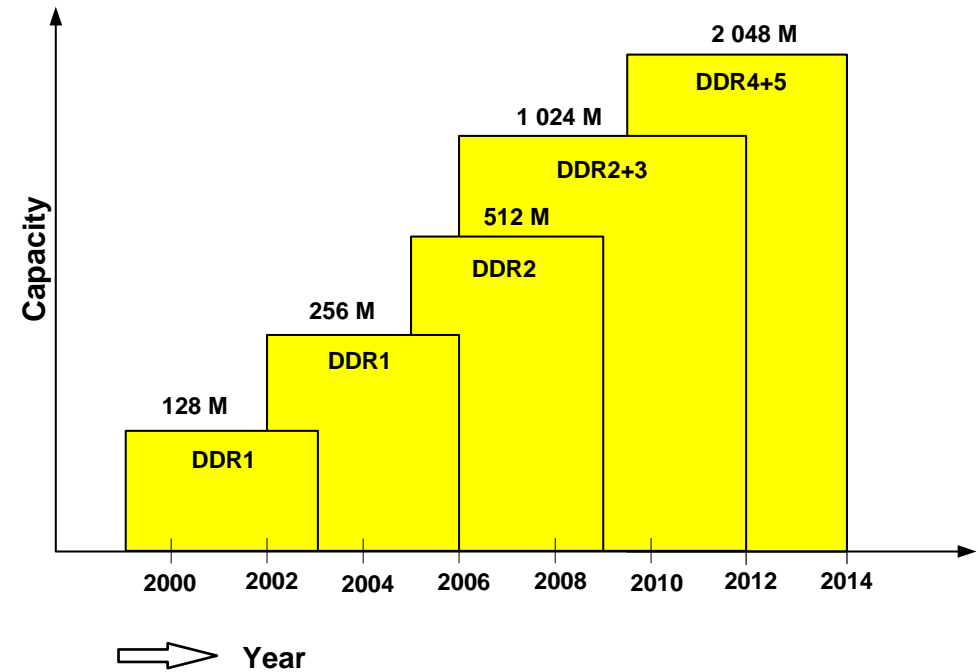
Evolution of the DDR 1/2/3 DRAM Technology

Near Term Projects

Project Name	Project Start Year	Capacity (Gbit)	Data Rates		Memory Module Type	DRAM Type	Additional Remarks
			Record	Replay			
TANDEM X	2006	600 BoL	2 Gbit/s	300 Mbit/s	UFM	SDRAM	Similar to TerraSAR-X Existing UFM will be used. Formatting, Encryption
Bepi Colombo	2007	512 BoL	40 Mbit/s	150 Mbit/s	HCMM / UFM / (new UFM back up)	SDRAM / (DDRRAM back up)	Simultaneous record and replay 10 User IF, 3 Downlink IF. SpaceWire IF, Flat File System, Formatting
GAIA PDHU	2007	768 BoL	70 Mbit/s	5 Mbit/s	UFM / (new UFM back up)	SDRAM / (DDRRAM back up)	Simultaneous record and replay Flat File System
K 3	2007	768 BoL	4 Gbit/s 2 x 90 Mbit/s	600 Mbit/s	new UFM	DDRRAM	Simultaneous record and replay Compression, Formatting, Encryption, File System
ENMAP	2008	768 BoL	2.2 Gbit/s	300 Mbit/s	new UFM	DDRRAM	Simultaneous record and replay SpaceWire, Formatting, Encryption, File System
Sentinel 1 Sentinel 2 Sentinel 3	2008 2009	2048 BoL	3 to 5 Gbit/s	600 Mbit/s	new UFM	DDRRAM	Simultaneous record and replay File System, Compression, Encryption, File System
TSX next 3…5 Gbit/s	2009	1000 BoL	4…6 Gbit/s	600 Mbit/s	new UFM	DDRRAM	Simultaneous record and replay Compression, Formatting, Encryption, File System
Earth Care	2010	600 BoL	2 Gbit/s	600 Mbit/s	new UFM	DDRRAM	ESA / JAXA
SAR Lupe next	2012	600 BoL	2 Gbit/s	600 Mbit/s	new UFM	DDRRAM	Simultaneous record and replay Compression, Formatting, Encryption, File System