Current and Future Advanced 3D-System-in-Package Spacecraft Subsystems

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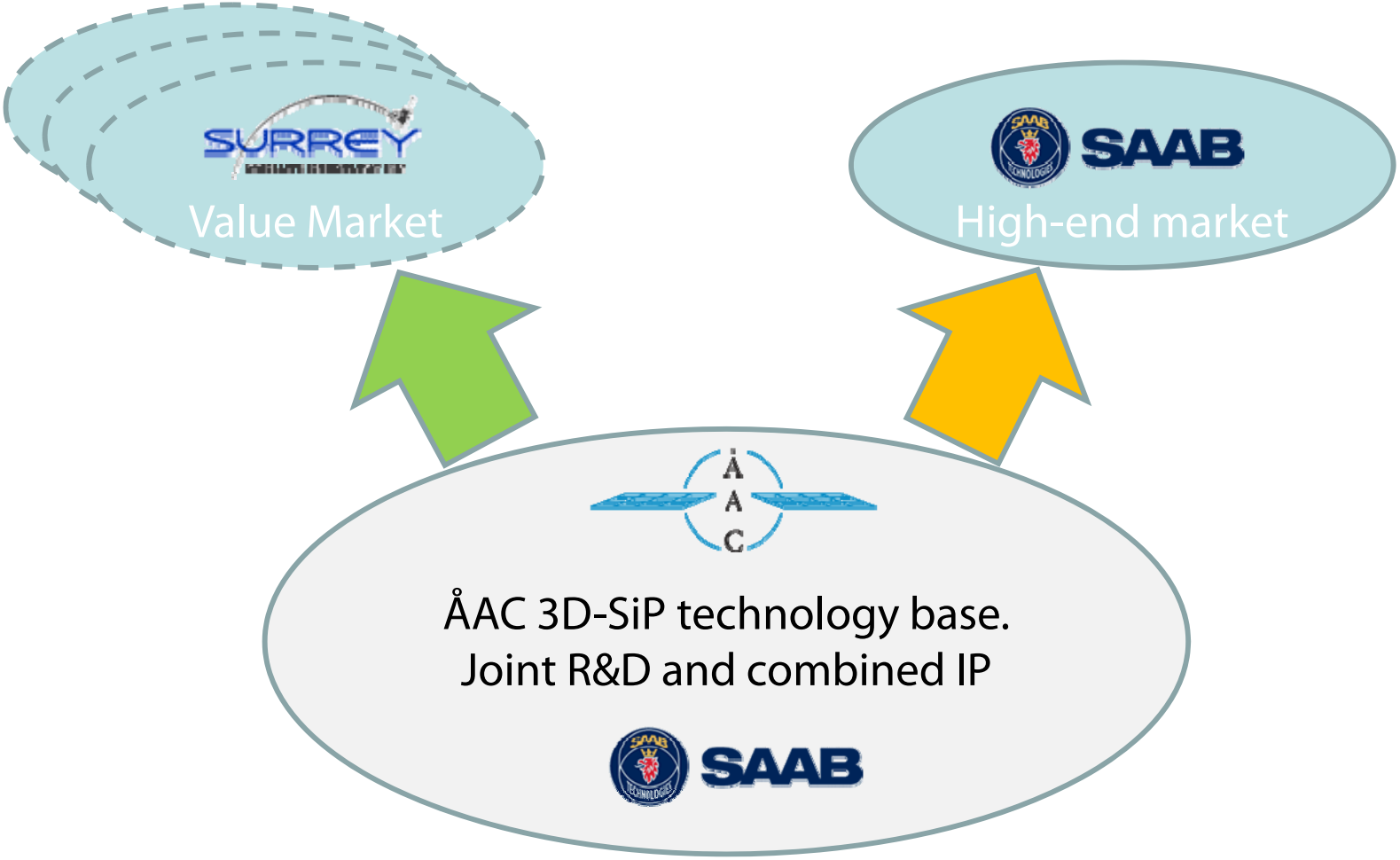
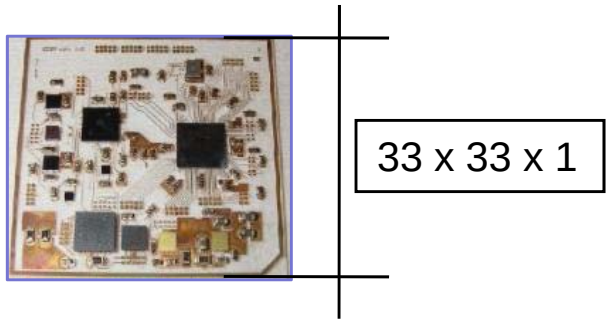
3D-SiP Market Introduction Collaboration



Recap from Previous Presentations on ÅAC 3D-SiP Subsystems

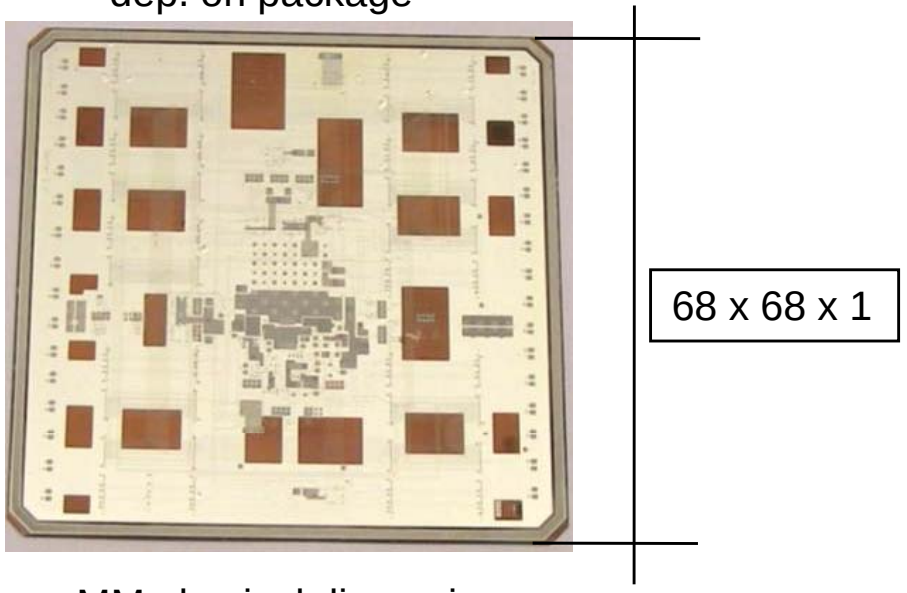
- ✓ 3D-SiP Remote Terminal Unit (RTU) together with Swedish Institute of Space Physics (IRFU)
- ✓ 3D-SiP Solid State Mass Memory (MM) together with SAAB Space
- ✓ 3D-SiP Magnetic Attitude Control System (MACS) together with ZARM Technik

Mass: 3-4 gram
dep. on package



RTU & MACS physical dimension

Mass: 20-30 gram
dep. on package



MM physical dimension

Development goal: Going COTS with 3D-SiP components

- Remote Terminal Unit
- Solid State Mass Memory
- Magnetic Attitude Control System

RYMDSTYRELSEN Swedish National Space Board

SAAB

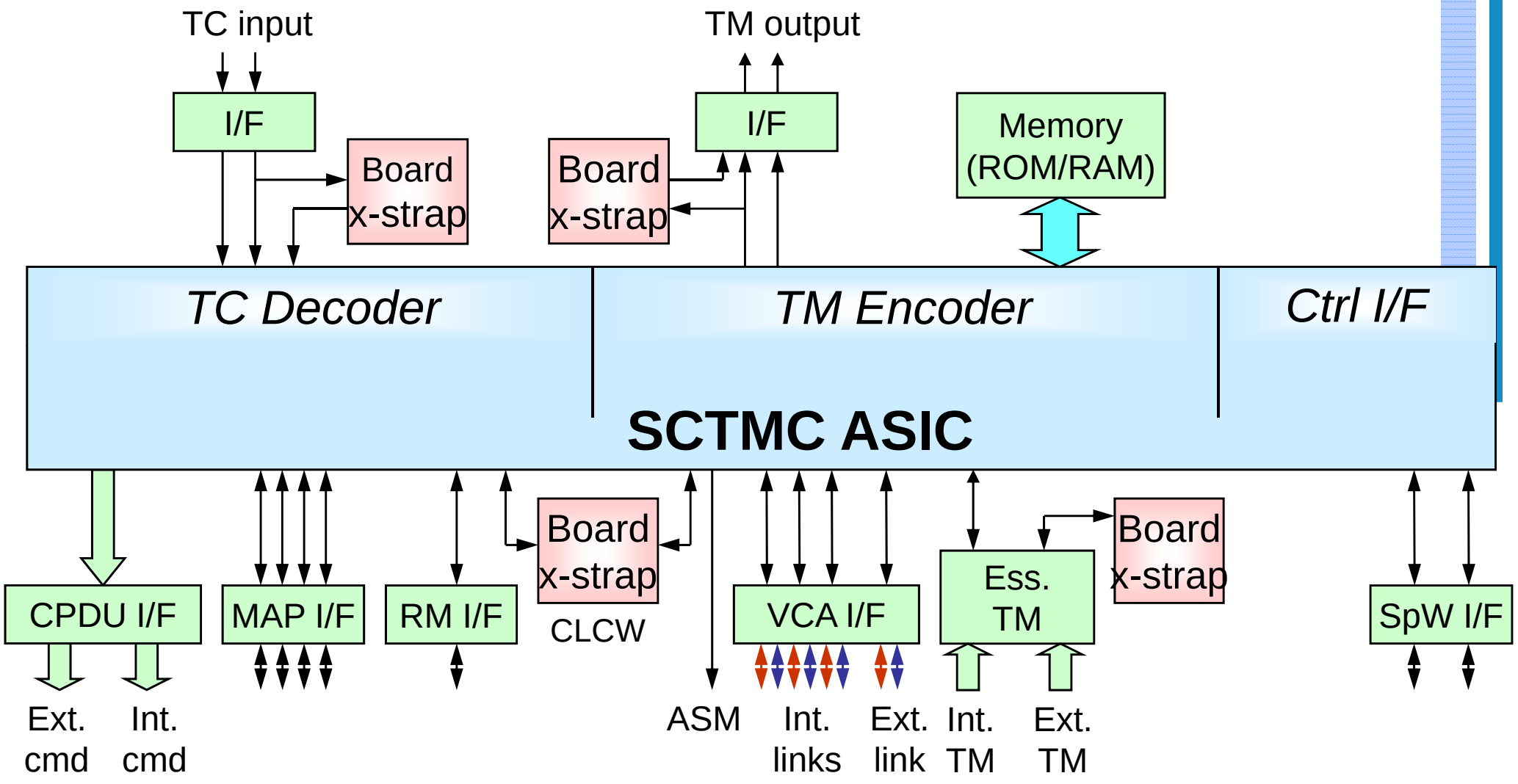
- Standardized Telemetry and Telecommand Module
- Miniaturized Distributed Power Modules
- RTU Gen 2 based on SpaceWireRTC

- High Speed Telemetry module
- GPS Receiver
- Micro kickmotor for deorbiting/orbit correction
- Internal spacecraft wireless communication modules
- Inertial navigation module
- . . .

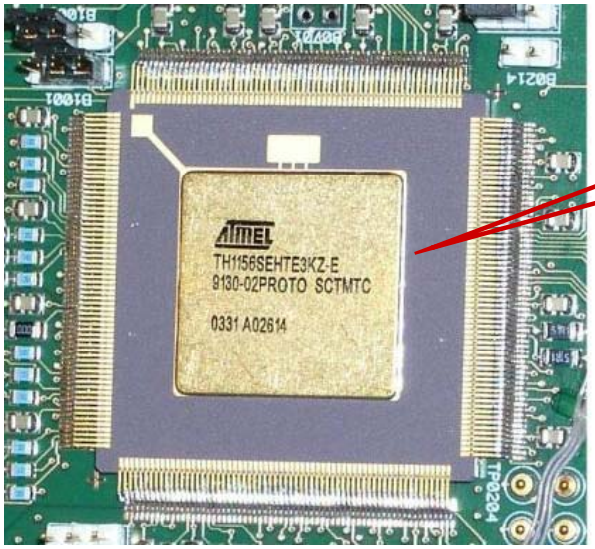
Proposed development: TMTC module, basic features

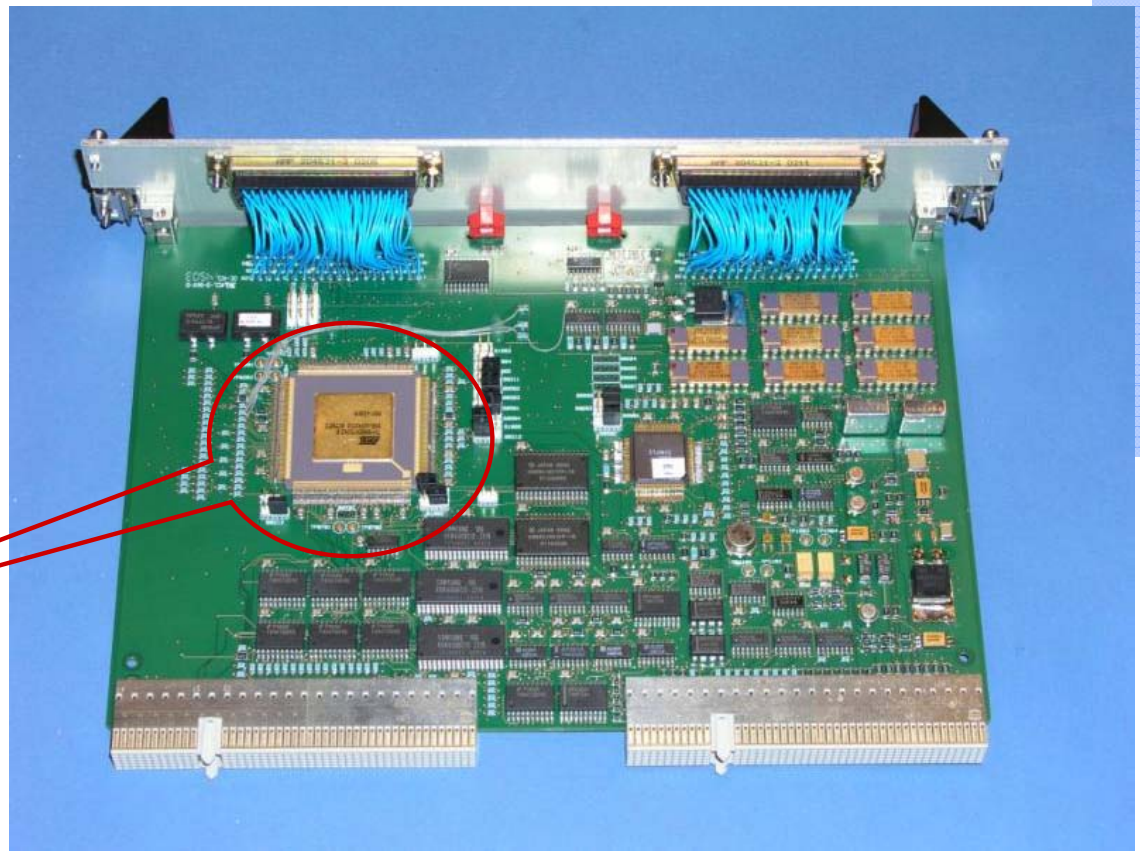
- System-on-chip technology to handle all ground link communication
  (uses the Saab Space CROME chip, also available as SCTMTC/AT7909E from Atmel)
- Can be operated independently from a processor but normally communicates with the processor using a SpaceWire link.
- Re-definable by the use of different external mission PROM
- TC uplink can operate at up to 50 kbps
- Provides a basic set of CPDU pulse command drivers plus an extension interface for additional external drivers
- Sends TC segments to the control processor(s) via two serial MAP interfaces
- Supports TM source packet reception up to 5 Mbps via PacketWire on up to five virtual channels
- Supports TM source packet reception from a controlling processor via SpaceWire on up to seven virtual channels
- TM downlink can operate at up to 5 Mbps

Typical TM/TC Board

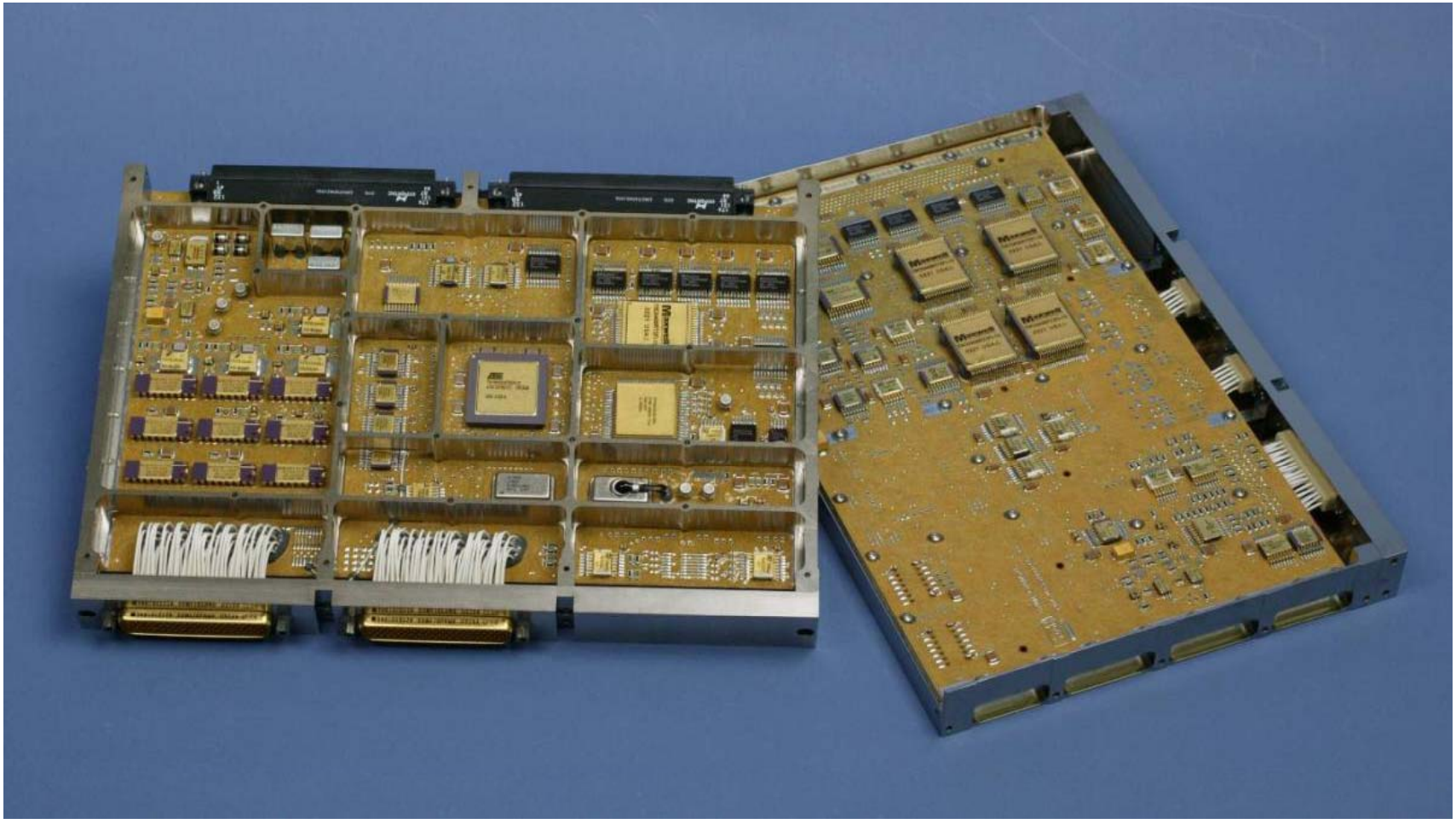


SCTMTC prototype PCB board

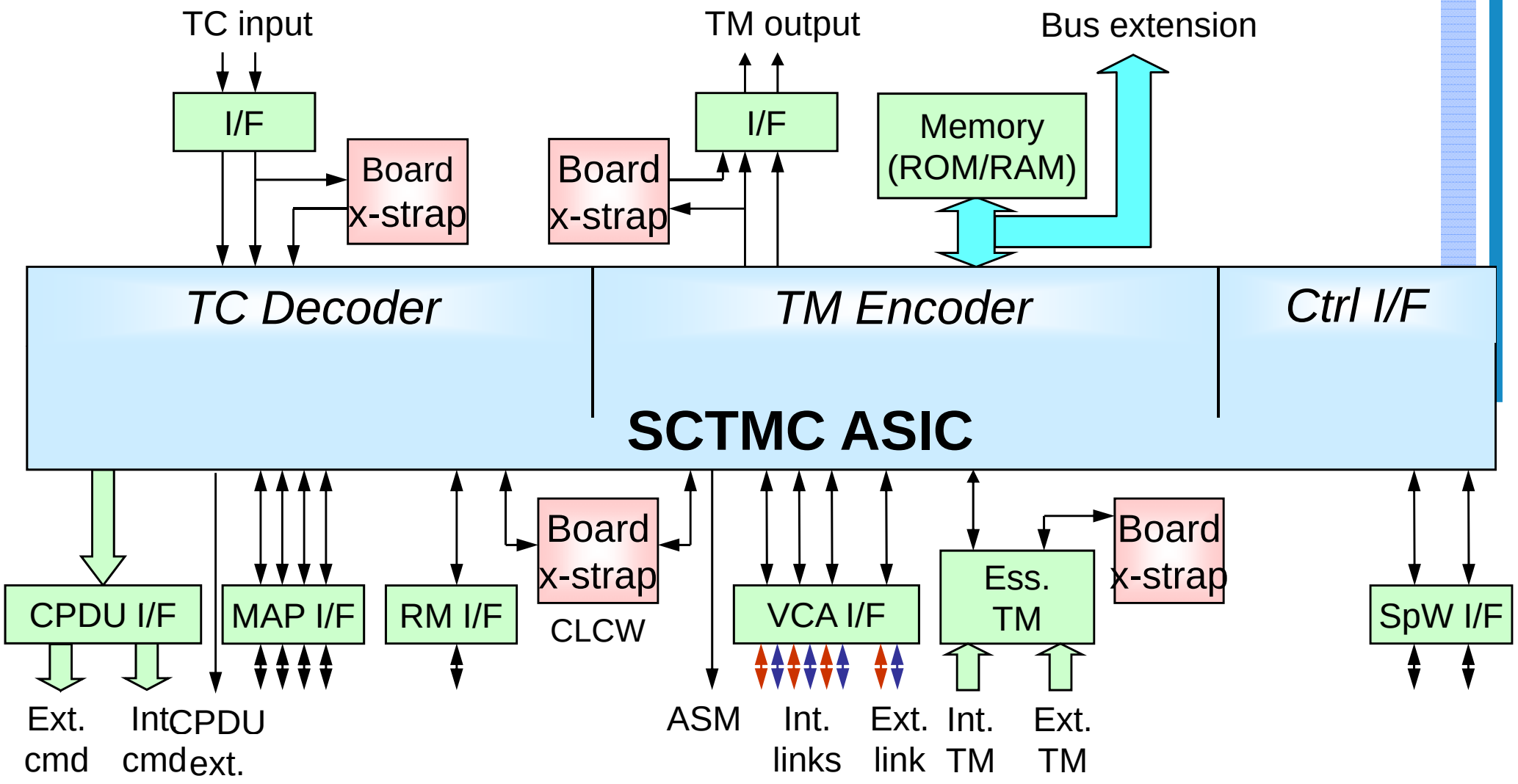




TMTC flight hardware board (ESA Herschel/Planck)

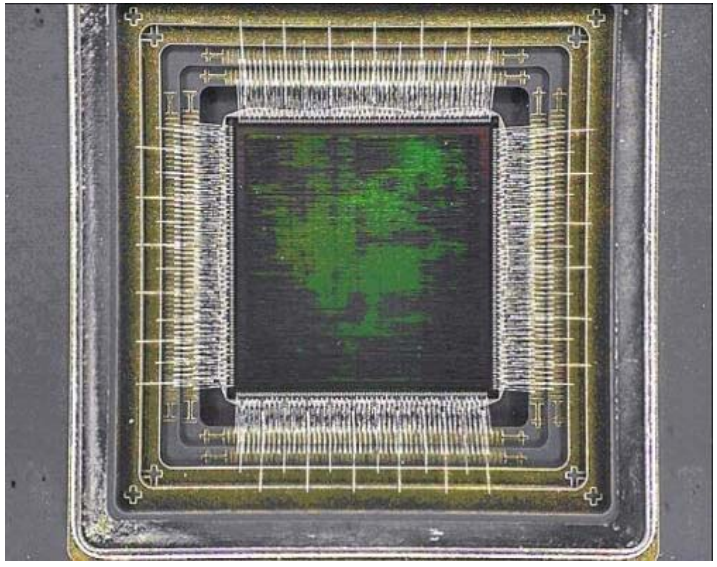


TM/TC Board stripped to a TM/TC module

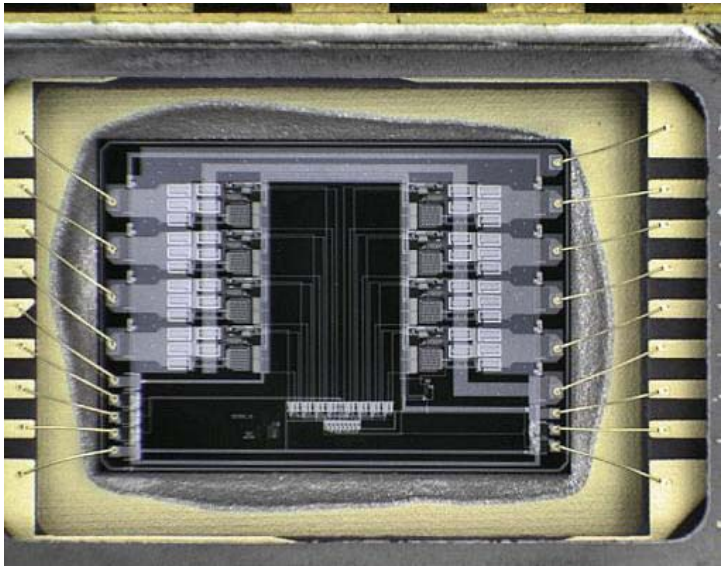


3D-SiP standardized TMTC

- The TMTC module is estimated to have a dimension like the Mass memory, 68 x 68 x 1 mm (standard µLinki frame)
- Estimated development time: 1 year
- Optional Patch antenna on to of module for complete solution



SCTMTC (CROME ASIC)

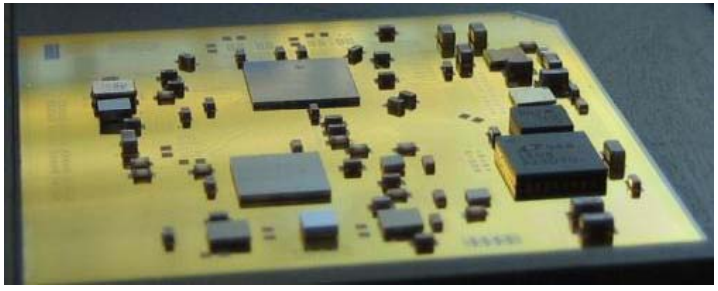


OCD ASIC (pulsedriver)

Science instrumention development

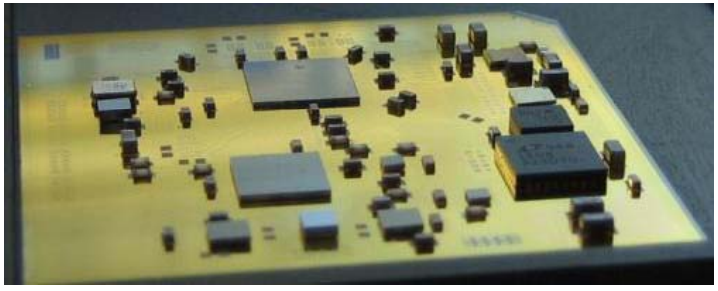
- Design meetings have been held with IRFU, KTH to streamline the 2nd generation RTU/CSIM to comply with internal Swedish science instrument requirements.
- Instrumentation prototype will fly on a Russian-Mexian satellite in 2008. PI is Dr Jan Bergman (Institute of Space Physics / ÅAC)
- Technology transfer and exchange between ÅAC and IRFU / KTH.

KTH Flux-Gate MGN



IRFU - LP

IRFU - Radio



Miniaturized Power Modules

- On-module switching/linear DC-DC converters

- Central switching converters from 24-270 V to 12 and 5 V

  why 270? Modern fighter jets and UAV's use higher voltages (like F22 Raptor). 3D-SiP costs must be shared over several application areas.

- Plug and Play configuration (fuseand latch-up/short circuit settings)

  A must for rapid response appications

Conslusions

- 3D-SiP technology is here to stay
- Enables a massive reduction of volume
- Enables a much easier system integration as a multifunctional element (thermal properties, structural element, electrical function, and possible electromechanical function)
- Next developments will conclude in a rough, but fully qualified library of modules, suitable for an extremly miniturized satellite platform bus or as subcomponents for other satellites