Multi Interface I/O Extension Card of T-Engine Platform for the Study of SpaceWire Protocol

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The Objective of SpaceWire Extension for T-Engine

- **Large capacity and high quality mission data transmission by high speed serial bus**
  - Standard high speed backbone data bus using IEEE-1355 (SpaceWire)
  - Router function for other standard interfaces as CAN, IEEE-1394, etc.
  - Flexible connection and/or selection of various sensors and cameras by Plug’n Play function

- **Exploiting system LSI technology**
  - “Satellite system on a Chip (SoC)” with large scale system LSI technology
  - Small size, light weight, and low cost satellite bus with straight forward technology evolution (without any quality de-grade)

- **Standardized real-time processing platform**
  - TRON and T-Engine technology for real-time processing platform.
  - Meta-level integration of various sub-systems using object-oriented design
    ⇒ Operation scheme and sensor integration are the same over various satellite mission
  - Flexible inter-component connection with standardized bus interface
Development Framework
- wide range collaboration

National Agencies, Universities, and Industries

NEC TOSHIBA
Space Systems
(Space System Integration)

NEC Electronics
(T-Engine devices,
T-Engine card,
Teacube)

NEC Group

NEC Soft
(Software Development)

Shimafuji Electric
(EMS of T-Engine)

JAXA

Osaka Univ.

Univ. of Tokyo

High Energy Lab.
The Real-time Processing Platform

- T-Engine

  - Standard T-Engine
  - micro T-Engine
  - nano T-Engine

Prof. Sakamura
SpaceTRON (STRON) Extension Card
(development code name)

- Evaluation Circuit Card Assembly (CCA) for T-Engine
  - Bus connection interface: T-Engine extension connector (140pins)
  - Applicable standard T-Engine: Connector Key Type 0404
    - T-Engine with PCI-bus interface
      - NEC VR5500 micro processor (64bit RISC) 800 MIPS
      - TOSHIBA TX4956 (64bit RISC) 400 MIPS with low power consumption
      - ARM and SH series might be applicable.
  - Board size: 150 x 75mm (T-Engine extension specification compatible)
  - SpaceWire interface (3-port) with wired connectors

<table>
<thead>
<tr>
<th>I/F</th>
<th>Controller</th>
<th>I/F connector #1</th>
<th>Transmission speed</th>
<th>Remark</th>
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<tbody>
<tr>
<td>PCI (Rev 2.1)</td>
<td>NEC : μPD72874</td>
<td>140pin</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>32bit / 33MHz</td>
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<tr>
<td>IEEE-1394</td>
<td>NEC : μPD72874</td>
<td>4pin x 3</td>
<td>Max 400Mbps</td>
<td>IEEE-1394a</td>
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<td>IEEE-1355</td>
<td>ATMEL : TSS901E</td>
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<td>SpaceWire</td>
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<td>CAN</td>
<td>Philips : SJA1000</td>
<td>D-sub 9pin x 1</td>
<td>Max 1Mbps</td>
<td>CAN 2.0B</td>
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STRON board outlook

■ Unified Architecture
  – 2 circuit card assemblies for CPU module and various data bus interface with PCI-bus connection
    • SpaceWire x 3ch, IEEE-1394 x 3ch, CAN x 1ch, Extension I/F x 1ch

■ Open collaboration
  – Developed by Industries with many advice from JAXA, Universities, and national laboratories.
  – Special thanks to 4Links Ltd. and CANON France for their advice.
Compatible test using 4Links’ SpaceWire-PCI

- Data Acquisition
- Data Transfer
- Data Transmission with parallel pass
- Continuous Data Transmission with sudden disconnection on some cables
- Control by Link operation
STRON board application
- Multi-protocol router for SpaceWire, CAN, FireWire, etc. using SpaceWire for back-bone.
STRON board road map (2)

■ STRON board application
  – Re-usable middle-ware and device driver software
    • Software distribution system over T-Dist framework of T-Engine Forum
    • Low cost evaluation board kit for commercial industries and students
      – Wide range of opportunities to joining space activities

■ Monolithic STRON chip exploiting system LSI technology
  • Future Plan

“Space nano T-Engine”
(ex) embedded interface for various sensors and actuators