CASE STUDY

TI AM6548 Sitara based board BSP implementation

AVISTO
EASTERN EUROPE

Case Study: TI AM6548 Sitara BSP

HW & FW Design Services

Avisto Eastern Europe has extensive experience in design of custom computer boards based on modern SoC solutions.

Our HW/FW teams were engaged early-on with our clients during detailed system requirements specification through system architecture design, development and verification providing the client with complete solution.

Close collaboration of HW and FW design teams accelerates development and ensures quality, while our experience in verification system design provides high quality end-product.

Comprehend the Client

Based on client functional specification for HW/ FW, requirements for BSP were defined.

Goal

Support all necessary board interfaces via board library and drivers.

Solution

Board library (DDR, NOR flash, pinmux), Ethernet driver, Second stage bootloader and HW test application were implemented.

Results

All required functionalities are supported in BSP. HW test application enabled efficient verification and testing.

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Comprehend Client

Based on client functional specification for HW/ FW, requirements for BSP were defined.

Firmware

Industrial Automation

The client is one of **the biggest industrial automation** companies, an innovative thinker and all-around solution provider in manufacturing industries.

Client successfully delivers wide range of industrial automation solutions from industrial controllers to machine programming software environment for quick development of **complex processes**.

Starting from the client's functional requirements regarding hardware and firmware of the computer board we had to thoroughly assess requirements and specification for board support package (BSP) in order **to provide efficient solution with maximum performance and minimal complexity**.

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Goal

Support all necessary board interfaces via board library and drivers.

Reliability & Performance

For custom designed computer board

Starting from the client's functional requirements regarding Hardware and Firmware of the computer board we had to thoroughly assess requirements and specification for board support package (BSP) in order to provide efficient solution **with maximum performance and minimal complexity**.

Therefore, our development had to fulfill the following goals:

- Provide **reliable and efficient BSP** for computer board and all the required interfaces/ functionalities.
- Ensure the means of HW/ BSP **verification** of the computer board design;
- Provide the means for **quick and reliable testing** of HW boards in production.

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Solution

Board library (DDR, NOR flash, pinmux), Ethernet driver, Second stage bootloader and HW test application were implemented.

BSP & Hardware

Custom modification

In order to reach previously defined goals, next actions had to be conducted:

A. BSP area of work

- Board Library Modification
- Ethernet Driver Customization
- NOR Flesh memory support
- Bootloader and flashing tool adaptation

B. Hardware Verification and Testing

- Design of application for Hardware and BSP verification
- Application for testing in production

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Solution

Board library modification for DDR, NOR flash, pinmux and Ethernet configuration.

Board Library

Custom modification

Board library performs basic SoC initialization. Default implementation was provided by Texas Instruments (TI) and had to be **extensively modified**.

Modifications in Board library are comprised of:

- Initial **Pin configuration** to bring the board in safe state and configure for certain peripherals (Ethernet interface, QSPI NOR interface etc.);
- **DDR** configuration (setting appropriate timing values);
- Initial **Ethernet configuration** provided initialization of MDIO interface and enabling of clock for PHYs (Ethernet physical interface chips).
- Create flash library to support QSPI **NOR flash**.

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Solution

Ethernet driver modifications for custom PHY and MMI mode.
Application layer for custom communication protocol.

Ethernet driver

PHY and MII mode support

Ethernet driver was based on the EMAC driver provided in TI Software development Kit (SDK). There was a need to support:

- customer’s specific PHY interface chips,
- modify driver to support MII mode of operation,
- design application layer for driver initialization and packet handling.

This solution provided small memory footprint and CPU requirements for customer’s specific **communication protocol** based on the **first two ISO layers** (physical and Data Link Layer).

Communication cycle time of 125 µsec was supported with minimum resources.

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Solution

NOR flash support for custom chip via QSPI interface.

NOR flash support

Over QSPI interface

Client's computer board used specific Quad SPI (QSPI) NOR flash chip which was not originally supported by TI's SDK. As a starting point flash library from TI based on the Octal SPI (OSPI) low level driver was used.

In order to do so, QSPI mode of communication was supported instead of OSPI mode. Moreover, NOR Flash chip didn’t exist in **flash library**, therefore, it was added.

Adaptation layer was designed to enable handling of **parallel access** to raw part of NOR flash memory (used for bootloader and application) as well we a part where **NOR flash file system** (NOR FS) is mounted.

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Solution

Secondary bootloader and flashing tool utility modification for NOR flash chip.

SBL and Uniflash modification

For QSPI/ NOR interface boot

TI Sitara SoC is utilizing **Secondary bootloader** (SBL) to enable booting from different media (UART, SDcard, flash memory, etc.).

QSPI NOR flash chip is used on the customer's board as a primary boot media. This chip was not supported in SBL, consequently, it was modified to support booting from this type of NOR flash.

In order to enable programming of non-removable flash devices on TI hardware platforms with application software image, TI provided **flashing tool utility** (Uniflash). Since TI's Uniflash tool did not support NOR flash memory used on customer's board it was redesigned to provide support for this specific chip.

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Solution

Application for automated Hardware verification and testing.

HW verification
and Testing application

HW verification and testing application was designed to provide simple, but efficient Command Line Interface for both **human and automated verification** and test system use. Via this interface specific test modules can be run, and results are reported to operator, developer or to the automated test system. Test included:

- GPIO configuration and pin state setting/ reading;
- DDR memory test (pattern test, walking ones/ zeroes);
- MMCSD interface verification/ test;

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Solution

Application for automated Hardware verification and testing.

HW verification

Test segments

- Ethernet interfaces test (digital/ external loopback and port to port test);
- QSPI NOR flash interface;
- CPU load test (activating all cores for max. power/temperature estimation);
- Board temperature readout;
- Secondary bootloader test (writing bootloader and application image to NOR and booting from NOR memory).

All stated above enabled us to successfully complete process of hardware verification.

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Results

All required functionalities are supported in BSP.

Effectively supported

All needed HW functionalities

- **Build environment** was modified in order to add client's board
- The client's board was added in **modified board library**
- **Ethernet driver** was redesigned to support **custom PHY**, efficient driver implementation enabled fast custom communication protocol with **125 µsec cycle**
- Supported **NOR flash chip** with communication over **QSPI interface**
- **Boot from NOR flash** was supported via QSPI interface and tool was provided for **programming NOR flash** bootloader and application image

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Results

HW test application enabled efficient verification and testing.

Automated Verification

Board HW verification and production testing

- **Hardware test application** with simple command line interface (**CLI**) was designed to complete **HW verification** and support **FW development**
- Hardware Test application is an integral part of **LabView** based verification environment, which enabled us to conduct **completely automated** verification and testing.
- All **relevant HW interfaces** (DDR test, MMCSD test, NOR flash test, Ethernet test etc.) have been verified and tested with the developed application.
- **Total test time** of all relevant interfaces is measured to be ~ **2 minutes.**

LET'S CONNECT!

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ABOUT US

AVISTO Eastern Europe

AVISTO Eastern Europe is a service provider that focuses on empowering Industrial automation and Semiconductor projects by offering tailored made solutions in areas of Embedded Systems, Test Automation, Application Software and DevOps.

Established in 2007, AVISTO currently operates three design centers in Serbia and boasts a strong network of experienced engineers empowered by high level of technical adaptability to meet the specific requirements and demands of clients' projects.

As a French company and a member of the Advans Group, which comprises over 1000 engineers, AVISTO can deliver comprehensive product-based development support to clients at the enterprise level.

THANK YOU