



# **A Gentle Introduction to SORBAS**

**Mobile Communications Project Group**

Computer Networks Research Group

University of Paderborn



## Software radio based prototyping system

- Software defined radio implementation of IEEE 802.11a
- OFDM-PHY
- Full 802.11-MAC-functionality



# Radio Frequency Card

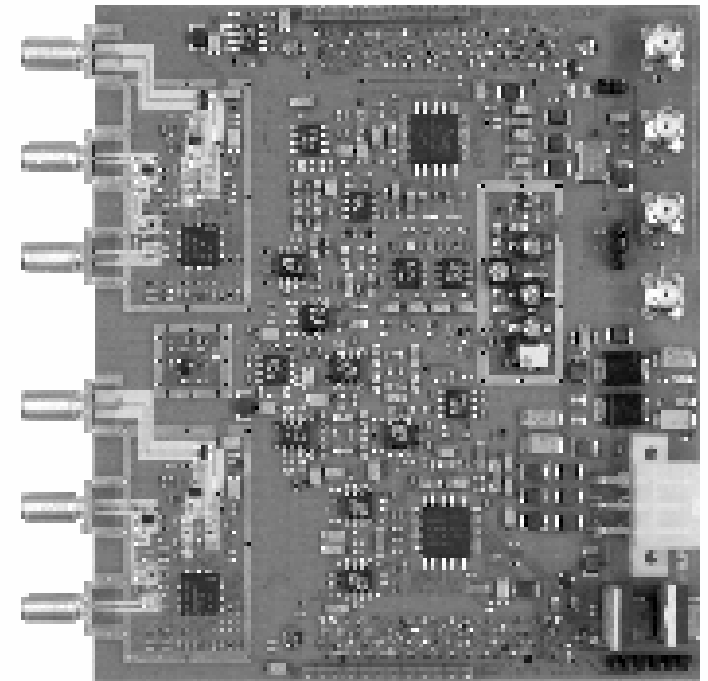


## AD/DA Conversion

- 10-bit, 80 MHz
- Analog Devices AD9861

## RF Transceiver

- 2.4-2.5 GHz, 5.15-5.875 GHz
- Infineon PMB 8680
- Output power -15 ... 11 dBm at 2.4 GHz
- Up to 30 dBm at 5 GHz using a high power module



# High Power Module



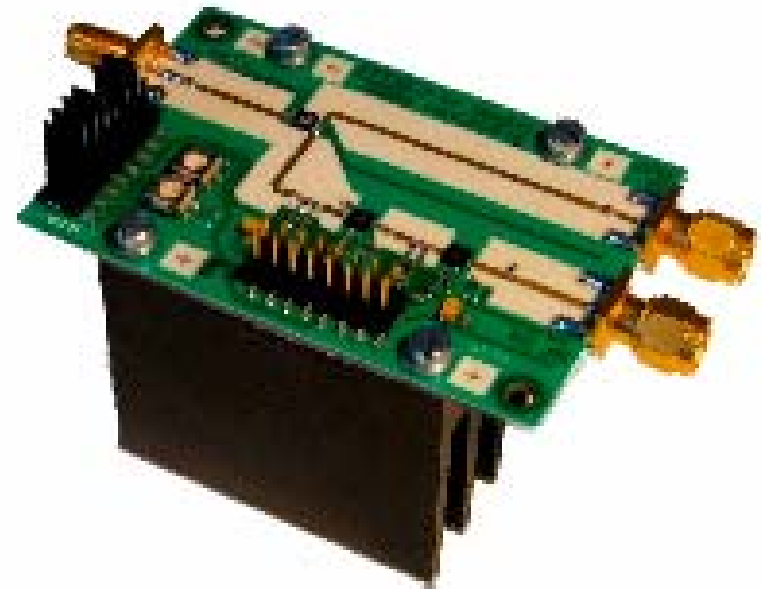
High gain power amplifier for ISM-bands

Frequency range

- 2.4 – 2.5 GHz (SMAC2)
- 5.1 – 5.9 GHz (SMAC5)

Gain

- Up to 20 dB (SMAC2)
- Up to 36 dB (SMAC5)



# Medium Access Control Card



## Processor

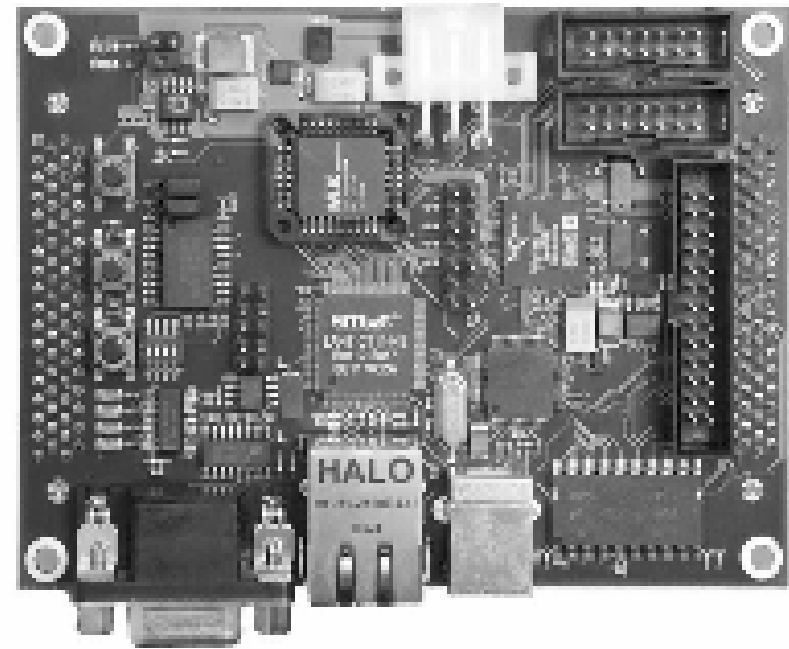
- Analog Devices Blackfin ADSP-BF533

## Interfaces

- Ethernet 10/100 Mbit/s
- USB 2.0
- UART

## Memory

- 32 MB SDRAM
- 512 KB Flash



# Digital Communications Card

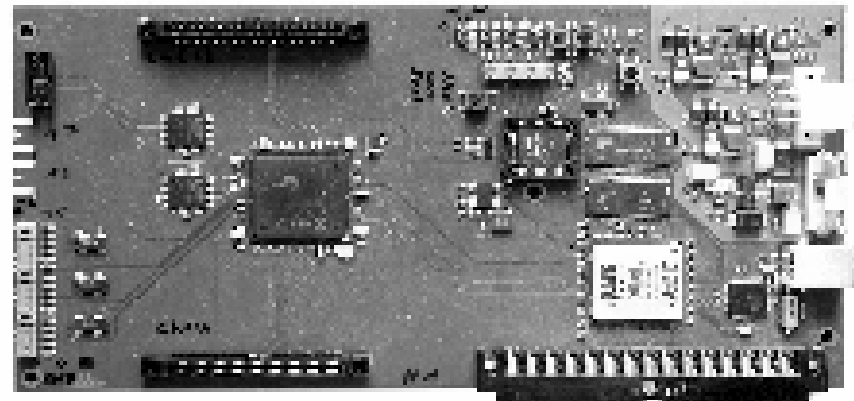


## Interface to daughter cards: SRFC/SMAC

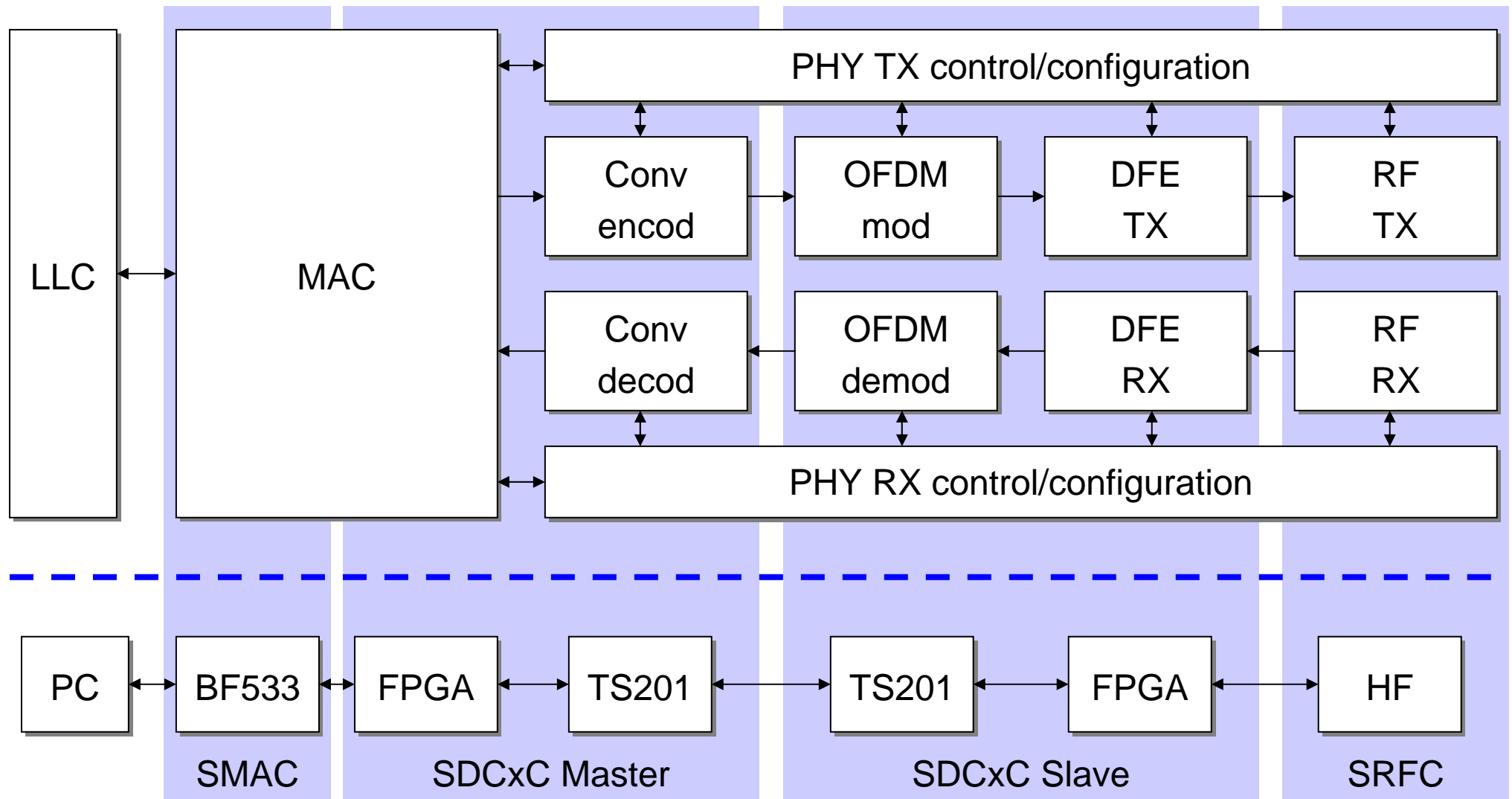
- In combination with SRFC, two independent transmitter or receiver branches

## Components

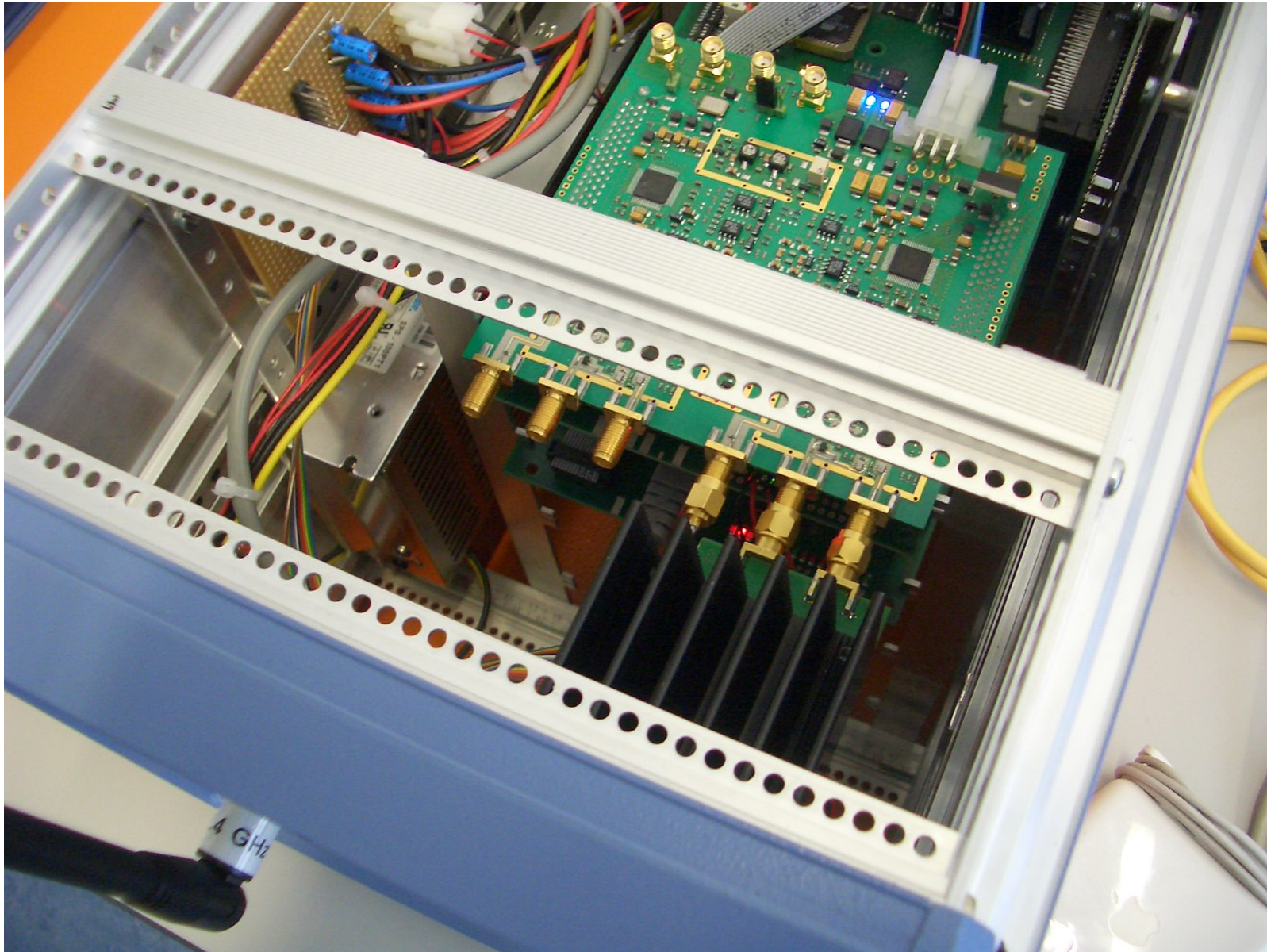
- Analog Devices TigerSHARC ADSP-TS201
- Xilinx Virtex-II XC2V2000
  - 2M system gates
  - 10,752 slices



# 802.11a Modem Implementation



# Behind the Surface





# Emulators

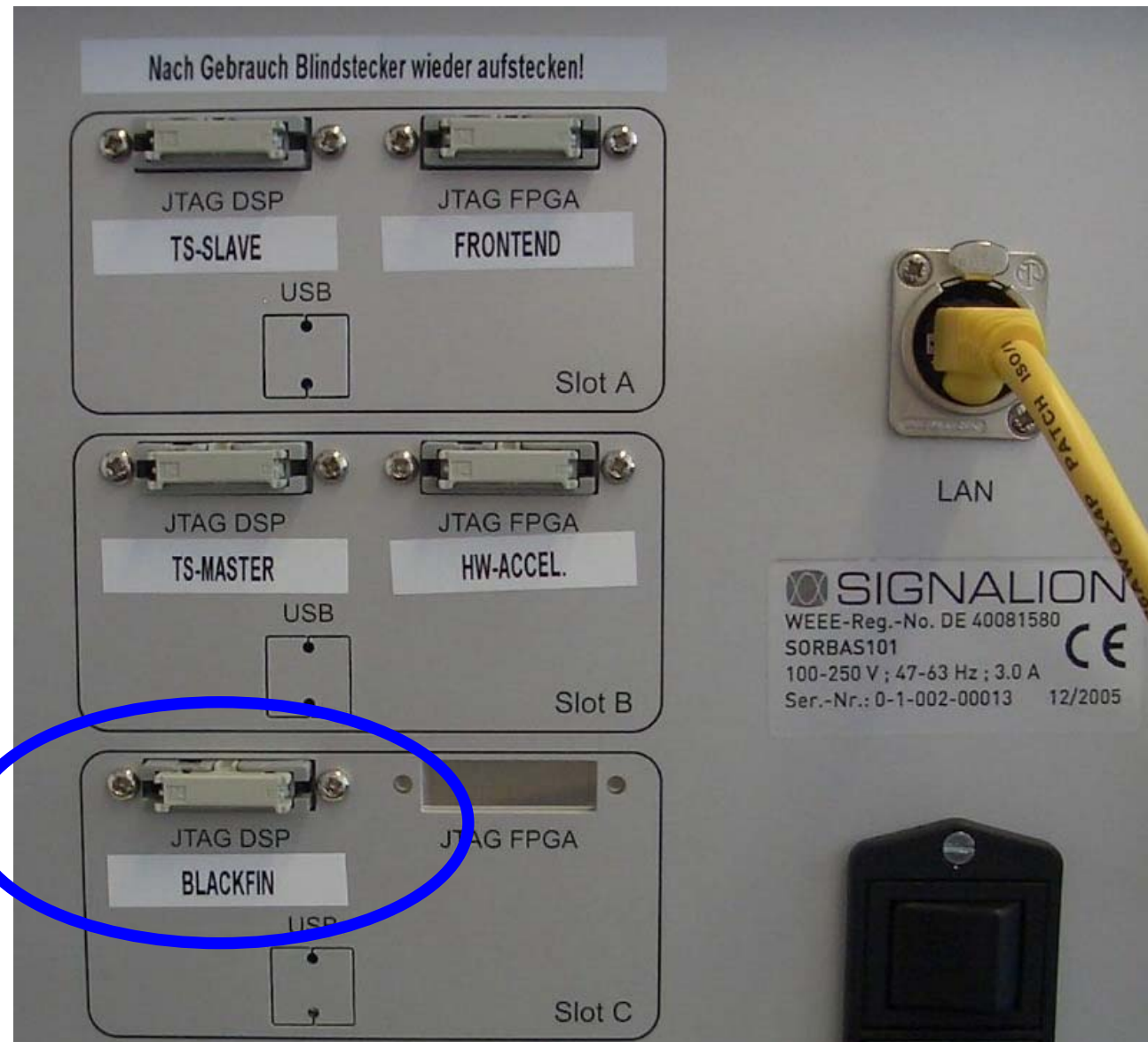


## JTAG Interface

- Downloading
- Flashing
- Debugging



Electrostatic  
Discharge





**VISUALDSP++**<sup>®</sup>

Integrated software development and debugging environment (IDDE)

**agk-lpc5:** C:\Daten\Signalion\Software\BF533

- Bf\_Mac4h\_051208\_int: IHP MAC Implementation
- SMAC\_flash\_040906: Flash driver
- SMAC\_init\_050801: SDRAM initialization

Bf\_Mac4h\_VDSP4 Debug

Project: Bf\_Mac4h\_VDSP4

Project Group (1 project)

- Bf\_Mac4h\_VDSP4
  - Source Files
    - Bf\_env4h.c
    - cpblab533.s
    - Mac\_Layer.c
    - MacSorts4.c
    - sctos.c
    - sctpred.c
    - sctsd.c
  - Linker Files
  - Header Files
    - lwp
    - MacSorts4.h
    - sctlocal.h
    - sctpred.h
    - sctypes.h

```

((yPDP_mlme_startrequest )S)->Param8 = Sig2I(&ptr);
((yPDP_mlme_startrequest )S)->Param9 = Sig2I(&ptr);
Sig2Rs(&ptr, &((yPDP_mlme_startrequest )S)->Param10);
Sig2Rs(&ptr, &((yPDP_mlme_startrequest )S)->Param11);
((yPDP_mlme_startrequest )S)->Param12 = Sig2I(&ptr);
}
SDL_Output ( S xSigPrioPar (xDefaultPrioSignal), (xIdNode *)0 );

/*MlmeReset.request*/
if ((code == 0x9A) && (k == 2))
{
    S = xGetSignal(resetmac, MlmePid, xEnv);
    Sig2Ma(&ptr, &((yPDP_resetmac )S)->Param1);
    ((yPDP_resetmac )S)->Param2 = Sig2I(&ptr);
    SDL_Output ( S xSigPrioPar (xDefaultPrioSignal), (xIdNode *)0 );

    if (temp_ptr=Mac_GetBuffer())
    {
        *(temp_ptr++) = 0xBA; /* signal MlmeReset.confirm */
        ISig(0, &temp_ptr); /* status is always "success" */
        *temp_ptr = -1;
        Mac_SignalOut();
    }
}

/*MlmeGet.request*/
if ((code == 0x9B) && (k == 1))
{
    if (temp_ptr=Mac_GetBuffer())
    {
        *(temp_ptr++) = 0xBB; /* signal MlmeGet.confirm */
        if (MlmeGet(ptr, &temp_ptr)) Mac_SignalOut();
    } /* wait on PHY response for RfChannel, CcaThres (CcaConfig, RfMode)*/
}

/*MlmeSet.request*/
if ((code == 0x9C) && (k == 2))
{
    if (temp_ptr=Mac_GetBuffer())
    {
        *(temp_ptr++) = 0xBC; /* signal MlmeSet.confirm */
        MlmeSet(ptr, &temp_ptr);
        Mac_SignalOut();
    }
}

/******
 * MAC extensions (MlmeBuffer, measurement functions etc.) */
 * from IHP update 050526, CUn, 31-May-2005 */
/******

/*MlmeBuffer.request, this signal is directly processed here */
if ((code == 0xA0) && (k == 3))
{
    n = Sig2I(&ptr);

```

Locals [Hexadecimal]

| Name                | Value       |
|---------------------|-------------|
| rx_cnt              | 0x00000000  |
| S                   | 0x2030004c  |
| ptr                 | 0x008000... |
| code                | 0x9b        |
| k                   | 0x00000001  |
| n                   | 0x00000001  |
| temp_ptr            | 0x008040... |
| dummy_short         | 0xffff      |
| ma                  | 0x00000002  |
| temp_os             | {...}       |
| Time_for_next_event | {...}       |

Call Stack

Function

- xInEnv(SDL\_Time)
- xMainLoop()
- main()

Disassembly

```

[FFA02D3C] R1 = FP ;
[FFA02D3E] R1 += -28 ;
[FFA02D40] R0 = [ FP + -36 ] ;
[FFA02D42] CALL MlmeGet ;
[FFA02D46] CC = R0 == 0 ;
[FFA02D48] IF CC JUMP 8 /*0xFFA02D50*/
[FFA02D4A] CALL Udp_SignalOut ;
[FFA02D4E] JUMP.S 2 /*0xFFA02D50*/ ;
[FFA02D50] JUMP.S 2 /*0xFFA02D52*/ ;
[FFA02D52] JUMP.S 2 /*0xFFA02D54*/ ;
[FFA02D54] R3 = B [ FP + -29 ] ( Z ) ;
[FFA02D58] R2 = 156 ( X ) ;
[FFA02D5C] CC = R2 == R3 ;
[FFA02D5E] IF ! CC JUMP 50 /*0xFFA02D9C*/
[FFA02D60] R1 = [ FP + -16 ] ;
[FFA02D62] CC = R1 == 2 ;
[FFA02D64] IF ! CC JUMP 44 /*0xFFA02D9C*/
[FFA02D66] CALL Udp_GetTxBuffer ;
[FFA02D6A] [ FP + -28 ] = R0 ;
[FFA02D6C] CC = R0 == 0 ;
[FFA02D6E] IF CC JUMP 32 /*0xFFA02D8E*/
[FFA02D70] P1 = R0 ;
[FFA02D72] R3 = -68 ( X ) ;
[FFA02D76] B [ P1 ] = R3 ;
[FFA02D78] R2 = P1 ;
[FFA02D7A] R2 += 1 ;
[FFA02D7C] [ FP + -28 ] = R2 ;
[FFA02D7E] R1 = FP ;
[FFA02D80] R1 += -28 ;
[FFA02D82] R0 = [ FP + -36 ] ;
[FFA02D84] CALL MlmeSet ;
[FFA02D88] CALL Udp_SignalOut ;
[FFA02D8C] JUMP.S 2 /*0xFFA02D8E*/ ;
[FFA02D8E] JUMP.S 2 /*0xFFA02D90*/ ;
[FFA02D90] R3 = B [ FP + -29 ] ( Z ) ;
[FFA02D94] R2 = 160 ( X ) ;
[FFA02D98] CC = R2 == R3 ;
[FFA02D9A] IF ! CC JUMP 196 /*0xFFA02E5E*/
[FFA02D9C] R1 = [ FP + -16 ] ;
[FFA02D9E] CC = R1 == 3 ;
[FFA02DA0] IF ! CC JUMP 190 /*0xFFA02E5E*/
[FFA02DA2] R0 = FP ;
[FFA02DA4] R0 += -36 ;
[FFA02DA6] CALL Sig2I ;
[FFA02DAA] [ FP + -12 ] = R0 ;
[FFA02DAC] CC = R0 <= 0 ;
[FFA02DAE] IF CC JUMP 14 /*0xFFA02DBC*/
[FFA02DB0] P1.I = 0x18c ;
[FFA02DB4] P1.H = 0xff80 ;

```

Output Window

```

C:\Dokumente und Einstellungen\gem.AGK-LPC5\Eigene Dateien\Bf_Mac4h_VDSP4\Bf_util.c(950):char* Udp_GetTxBuffer(void)
C:\Dokumente und Einstellungen\gem.AGK-LPC5\Eigene Dateien\Bf_Mac4h_VDSP4\Bf_util.c(1278): if (ptr = Udp_GetTxBuffer()){
C:\Dokumente und Einstellungen\gem.AGK-LPC5\Eigene Dateien\Bf_Mac4h_VDSP4\Bf_util.c(1329): if (ptr = Udp_GetTxBuffer()){
4 occurrence(s) have been found.

Cannot read memory while target is running.
Cannot read memory while target is running.
Cannot read memory while target is running.
Cannot read memory while target is running.
Cannot read memory while target is running.
Cannot read memory while target is running.
Cannot read memory while target is running.

```

# Ethernet Interface



Higher protocol layers use an Ethernet interface

## UDP WinTerminal

- Generate control signals
- Generate data signals
- Displays incoming signals
- Displays outgoing signals
- E.g. m1meStart.request, m1meStart.confirm



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Thank you for your attention.