KVI

university of groningen

GSI

SODANET Specifications

And Current Status of the Implementation

M. Drochner, M. Kavatsyuk, H. Kleines, P. Lemmens, J. Michel, M. Palka, P. Schakel

SODA Workshop (January, GSI)

Responsibilities, time scales, resource requirements

- Study group to define SODA protocol for SODAnet
  - Myroslav Kavatsyuk, {Chair} Peter Lemmens, Peter Schakel, (KVI), Marek Palka (Krakow), Matthias Drochner, Harald Kleines (Jülich), Jan Michel (Frankfurt, consulting)
    - Results should be reported during the April DAQ Workshop
- Feasibility of synchronous timing with TRB V3 (jitter measurement)
  - Marek Palka (Krakow), Jan Michel (to be approved by J.Stroth)
    - Should be ready by mid February
      - Results should be reported during the April DAQ Workshop
- Implementation SODAnet source on TRB3
  - Peter Lemmens (KVI) with help from Marek Palka (Krakow) and Jan Michel (Frankfurt)
    - Should be ready by end of June

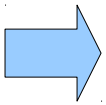
Open questions

- Explore potential synergies between CBMnet and SODAnet
- Explore hardware options for burst-building network

SODA Workshop (January, GSI)

Responsibilities, time scales, resource requirements

- Study group to define SODA protocol for SODAnet
  - Myroslav Kavatsyuk, {Chair} Peter Lemmens, Peter Schakel, (KVI), Marek Palka (Krakow), Matthias Drochner, Harald Kleines (Jülich), Jan Michel (Frankfurt, consulting)
    - Results should be reported during the April DAQ Workshop



Tested by Jan Michel and Michael Traxler (January 16):
- Synchronous connection works for TRB V3
- First recovery of a clock: 30 ps jitter (10 ps from oscilloscope)
- 6 recoveries in chain: 40 ps jitter

- Implementation SODAnet source on TRB3
  - Peter Lemmens (KVI) with help from Marek Palka (Krakow) and Jan Michel (Frankfurt)
    - Should be ready by end of June

Open questions

- Explore potential synergies between CBMnet and SODAnet
- Explore hardware options for burst-building network

SODANET

Design considerations:

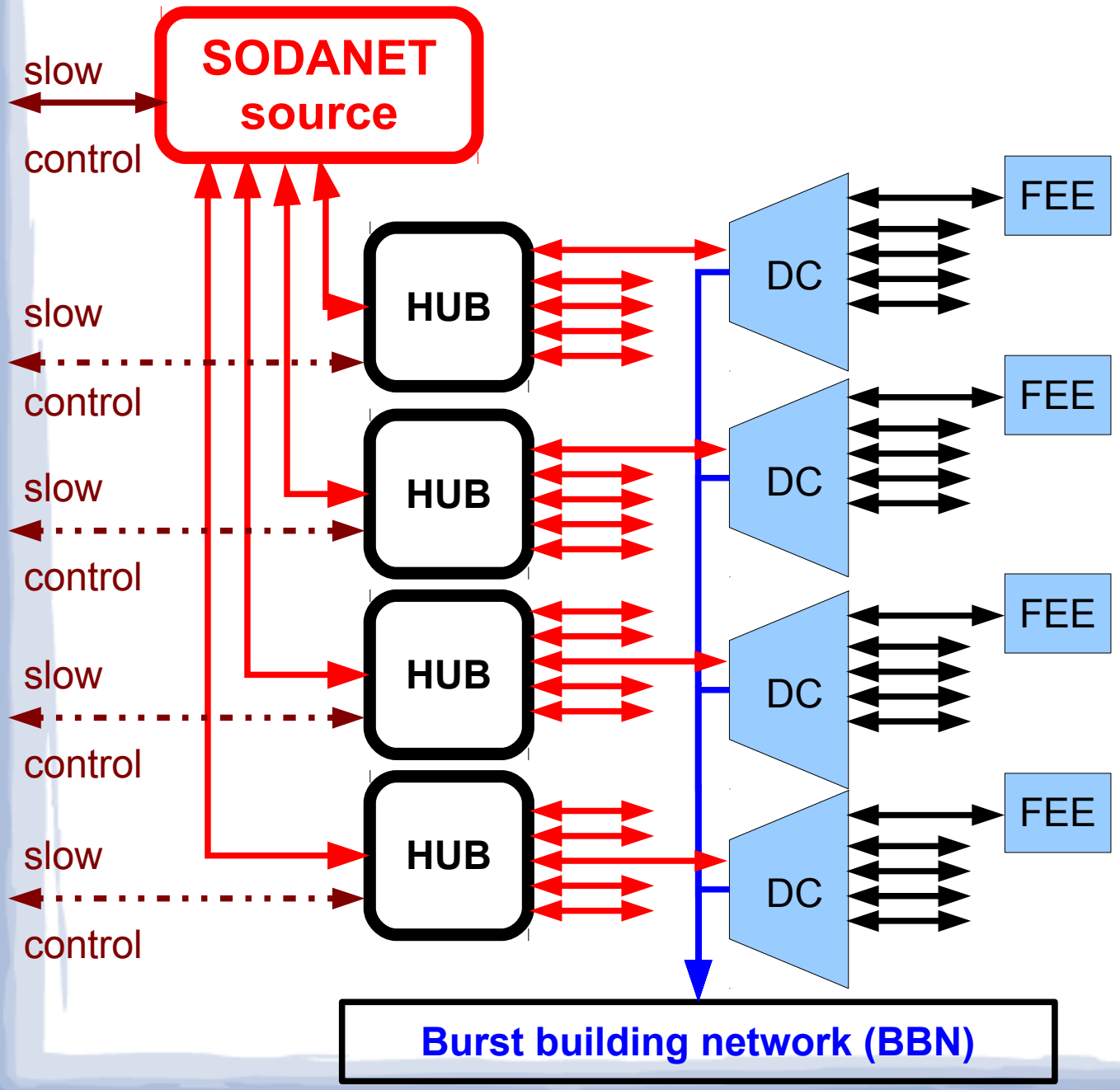
- Preserve readout topology as defined in the PANDA TPR
- Reuse as much as possible code of the TRBNET
- Key changes of the TRBNET compatible with the CBMNET protocol

SODANET Functionality

SODANET provides:

- synchronization of the FEE
- Continuous monitoring of the DC/FEE functionality
- Rough (initial) time calibration of the propagation time of the synchronization signal
- Transfer of a slow-control (FEE configuration/status) information: low priority, transmission of a slow-control package can be interrupted at any time by a synchronization package

SODANET Topology



SODANET link:

- Bidirectional
- Synchronous (only in one direction)
- Transfer:
  - source → DC: synchronization information and FEE configuration
  - DC → source: slow control, used for time calibration

Data link (DC → BBN):

- Unidirectional Ethernet

Link DC ↔ FEE:

- Bidirectional, synchronous
- Protocol up to subsystem

SODANET Synchronous Packages

SODANET protocol foresees two types of sync. packages:

- Command data: issued at any time
- Super-burst start (**super burst = 16 bursts of 2.4 μs**): issued at the beginning of each Super-burst

Package structure

K (FB)	Data 31-24	K (FB)	Data 23-16	K (FB)	Data 15-8	K (FB)	Data 7-0

Command package:

- Bit 31: 0
- Bit 30: Time calibration
- Bit 29: DAQ start
- Bit 28: DAQ stop
- Bit 27: Reset
- Bits 26-8: reserved
- Bits 7-0: CRC checksum (CRC8-CCITT)

Super-burst start package:

- Bit 31: 1
- Bits 30-0: Super-burst number

Synchronous Packages

- Have highest priority (interrupt any other transfer)
- Each received SODANET packed – acknowledged:
  continuous monitoring of the readout
  - Malfunction of one of the DC/FEE → trigger slow control;
    the malfunction DC – added to the list of non-uses recipients

- Burst counting (within Super-burst) – at each DC
  Error handling:
  - DC checks if received super-burst number is sequential
  - In case of error:
    - the DC uses number distributed by the SODANET,
    - set special error bit in the output data,
    - informs slow-control system
  - If part of SODANET message is missing:
    - DC uses super-burst number from a local counter,
    - reports problem to the slow-control system.

Time Calibration

- Dedicated “time calibration” command is defined
- Once the command is received:
  - reply sent to the transmitter side,
  - original message is forwarded further through the network.
- Propagation time:
  - calculated at the transmitter side
  - stored in a register
  - the register values – read out by a slow control system.
- The delay data – used to pre-calculate signal-propagation delays (~10 ns precision)
- Delay values – used at the DC to delay SODANET-synchronisation signals, before redistribution to FEE.
- The longest delay value – used by the SODANET source to **send synchronisation commands prior to a bunch crossing**

“Triggered” Mode

Compatibility mode of operation

- External “trigger” signal is feed to one of the DC/SODANET source
- “trigger” is timestamped, and sent to the burst-building network
- Event builder will select only hits with timestamps, which are in coincidence with the “trigger” signal

DC Output Data-format

- DC can start transmitting FEE data once it is available
  (without waiting till the end of a super-burst)
- If no data are available –
  DC sends an empty package at the end of the Super-burst

Data-package

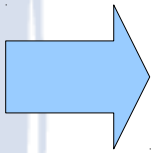
31 16	15 0
last-packet flag; packet number	data size in bytes
Not used (same as HADES)	Not used (same as HADES)
Status and error	System ID
Super-burst number	
Data	

GbE paket builder in FPGA (HADES) can be reused to pack data

SODA Workshop (January, GSI)

Responsibilities, time scales, resource requirements

- Study group to define SODA protocol for SODAnet
  - Myroslav Kavatsyuk, {Chair} Peter Lemmens, Peter Schakel, (KVI), Marek Palka (Krakow), Matthias Drochner, Harald Kleines (Jülich), Jan Michel (Frankfurt, consulting)
    - Results should be reported during the April DAQ Workshop
- Feasibility of synchronous timing with TRB V3 (jitter measurement)
  - Marek Palka (Krakow), Jan Michel (to be approved by J.Stroth)
    - Should be ready by mid February
      - Results should be reported during the April DAQ Workshop
- Implementation SODAnet source on TRB3
  - Peter Lemmens (KVI) with help from Marek Palka (Krakow) and Jan Michel (Frankfurt)
    - Should be ready by end of June



Open questions

- Explore potential synergies between CBMnet and SODAnet
- Explore hardware options for burst-building network

SODANET
Implementation status

- ✔ Cleaned-up SODANET VHDL repository (files, relevant only for the SODANET)
  - ✔ Implemented synchronous transmission at 100 MHz on the main and preferential FPGAs of a TRB board [hardware test]
- ✔ Super-burst generator (source) [tested with simulations]
- ✔ Package builder (source) [tested with simulations]
- ✔ Package handler (source/hub/DC) [tested with simulations]
- ➔ Interface of the SODANET to the TRB slow control
- Feedback handler (time calibration, monitoring)
- Fix synchronous-transmission frequency at 77.76 MHz (design does not work jet at 125 MHz)
- Jitter cleaner addon

SODANET
Implementation status

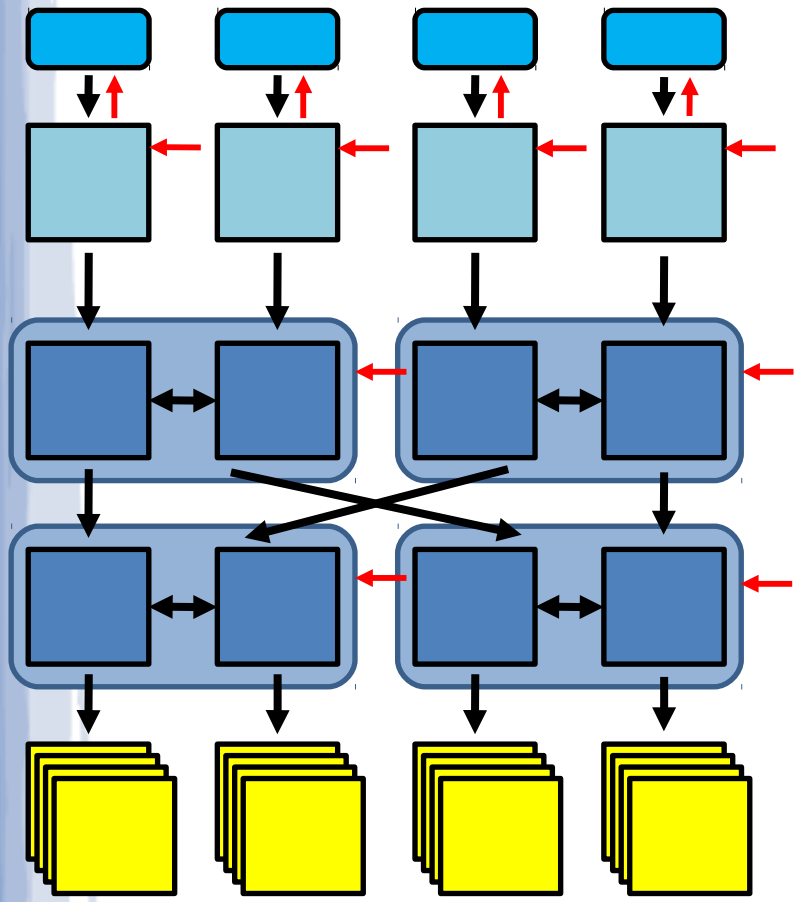
- ✔ Cleaned-up SODANET VHDL repository (files, relevant only for the SODANET)
  - ✔ Implemented synchronous transmission at 100 MHz on the main and preferential FPGAs of a TRB board [hardware test]
- ✔ Super-burst generator (source) [tested with simulations]
- ✔ Package builder (source) [tested with simulations]
- ✔ Package handler (source/hub/DC) [tested with simulations]
- ➔ Interface of the SODANET to the TRB slow control
- • Feedback handler (time calibration, monitoring)
- • Fix synchronous-transmission frequency at 77.76 MHz
  (design does not work jet at 125 MHz)
- • Jitter cleaner addon

Thank you for your attention!

PANDA Readout

using **Data links** (←) and Time distribution (←) "SODA"

[I. Konorov et al., NSS/MIC Conf. Rec., 2009 IEEE, DOI 10.1109/NSSMIC.2009.5402172]



Detector Front-ends — Hit detection, feature-extraction

Data Concentrator — Combine several Front-Ends

First Stage "Event" Builder

Second Stage "Event" Builder — Time-ordering (building physics events)

Compute Node — On-line processing of complete events, Accept/reject decision

Time-Synchronisation: Requirements

… To be precisely defined

- **Desired**:
  - Distribution of clock (154.52 SONET standard)
  - Distribution of synchronisation commands (Start, Stop, Calibration light-flash, etc.)
  - Acceptable jitter:
    - < 20 ps (TOF, DIRC)
    - < 100 ps (EMC)
    - < 200 ps (STT, MWD, etc.)
  - Signal distributed over an optical fibre

- **Optional**:
  - Measurement of a signal-propagation time (cable length)
  - Distribution of detector-configuration data
  - Configuration of the burst-building network
  - Slow control for small subsystems