A DYNAMIC BEAM SCHEDULING SYSTEM FOR THE FAIR ACCELERATOR FACILITY

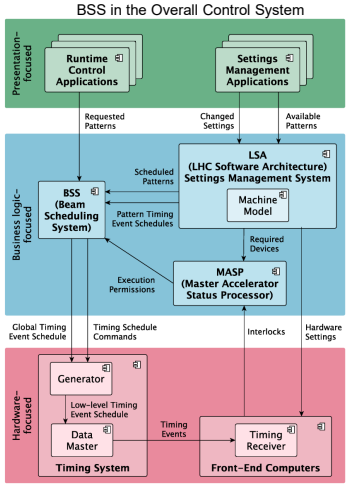
S. Krepp, J. Fitzek, H. Hüther, R. Mueller, A. Schaller, A. Walter,
GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

MOPV013

System Overview and Core Functionality

Beam Scheduling System (BSS)

- In the FAIR Settings Management System (LSA), beams are represented as Beam Production Chains and are put together to Patterns for defining an execution sequence.
- BSS on the other hand is the **central instance to orchestrate the execution** of these **Patterns**.
- BSS integrates the individual Pattern schedules provided by LSA into a global Timing Event Schedule which is passed to the Timing System.
- BSS evaluates user requests and execution permissions from MASP (a component of the Machine Protection System), in order to decide which patterns should be scheduled for execution and which not.
- In order to dynamically enable or disable the execution of certain patterns it utilizes a Command API provided by the Timing System.



Global Timing Schedule Configuration

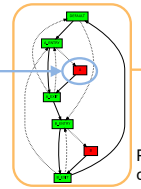
Pattern Schedule

- Provided by LSA
- Defines sequence of events used for one beam

Schedule for Pattern A

Pattern Group Schedule

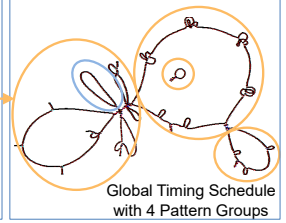
- LSA also defines Pattern Groups
- Patterns of one group must be executed sequentially and respect a configured execution order
- Patterns in different groups run in parallel but can be synchronized for beam transfer
- BSS integrates individual Pattern schedules into a Pattern Group Schedule Graph
- BSS adds a Default Pattern for idle operation



Pattern Group Schedule containing Patterns A, B plus Default Pattern

Global Timing Schedule

- BSS integrates Pattern Group Schedules into global Timing Event Schedule
- BSS dynamically performs schedule changes via Timing Schedule Commands



Global Timing Schedule with 4 Pattern Groups

Requests for Pattern Execution

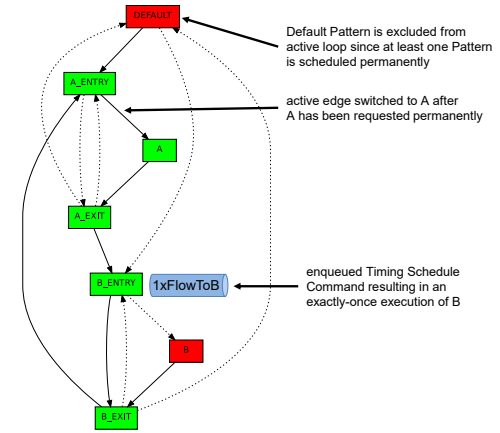
Permanent Requests

- The most basic BSS use case
- Permanent requested patterns are activated in the corresponding Pattern Group Schedule and periodically executed within the Pattern Group loop.
- Schedule edges are switched accordingly

Non-Permanent Requests

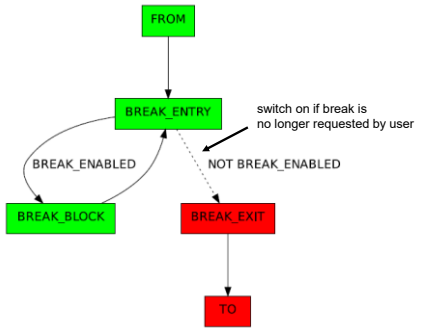
- Pattern is scheduled for an exactly-once execution
- Allows experiments to request single beam shots
- This is done by writing a Flow Command into the Pattern's entry queue which results in jumping into the actual Pattern Schedule without switching edges, when the command is consumed

Pattern Group Schedule with A being requested permanently and B scheduled for an exactly-once execution



Dynamic Pattern Schedule Path Switching

Enabled Breakpoint Loop in a Pattern schedule



- More recently Storage Ring Mode has been introduced into the FAIR Control System
- It provides features such as Breakpoints, Skipping, Repetitions and Manipulations in Pattern schedules, see [WEPV047]
- Storage Ring Mode features rely on dynamic switching between alternative execution paths in running Pattern schedules
- → BSS provides a **signal based API** for **interacting with running Pattern schedules**
- e.g. enable and disable certain parts of executed Pattern schedules, by switching schedule edges depending on state changes of certain signals

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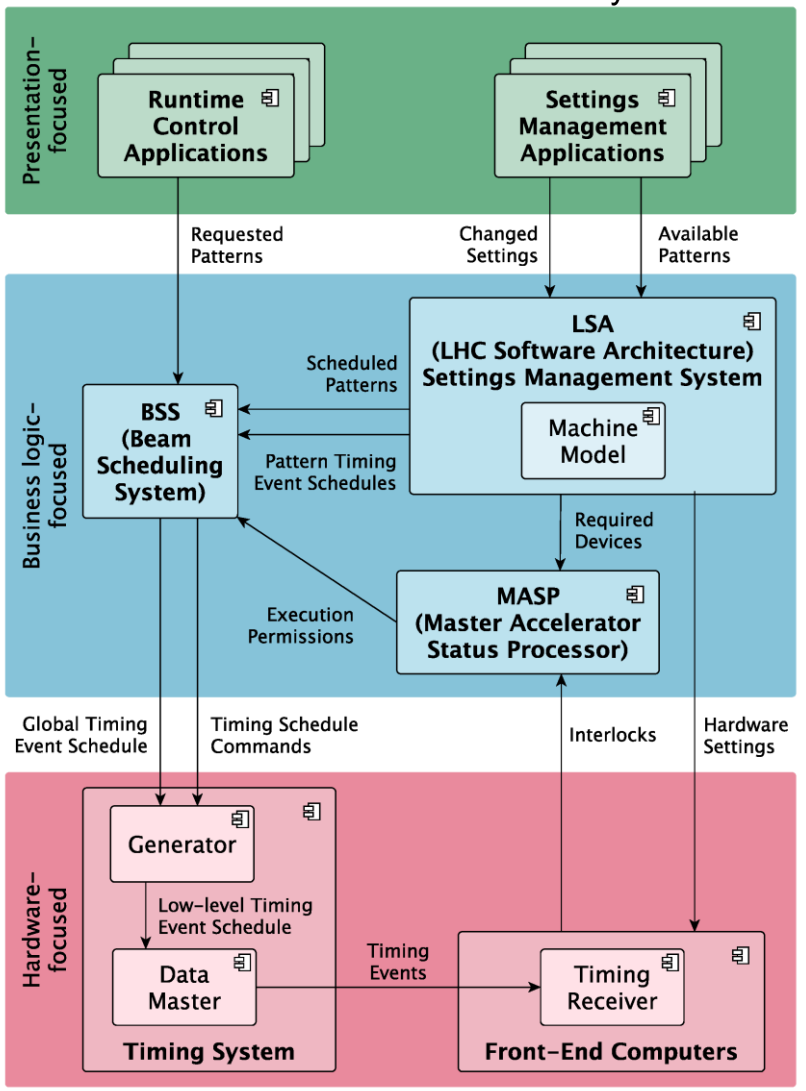
BSS in the Overall Control System



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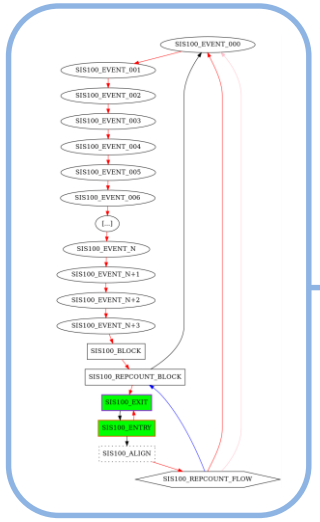

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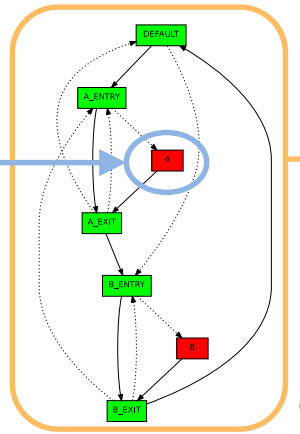

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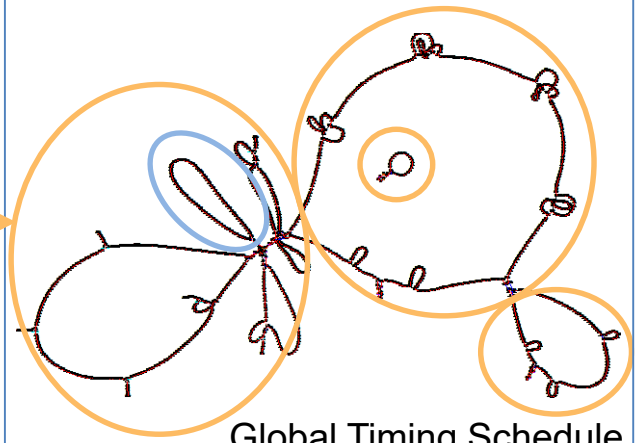

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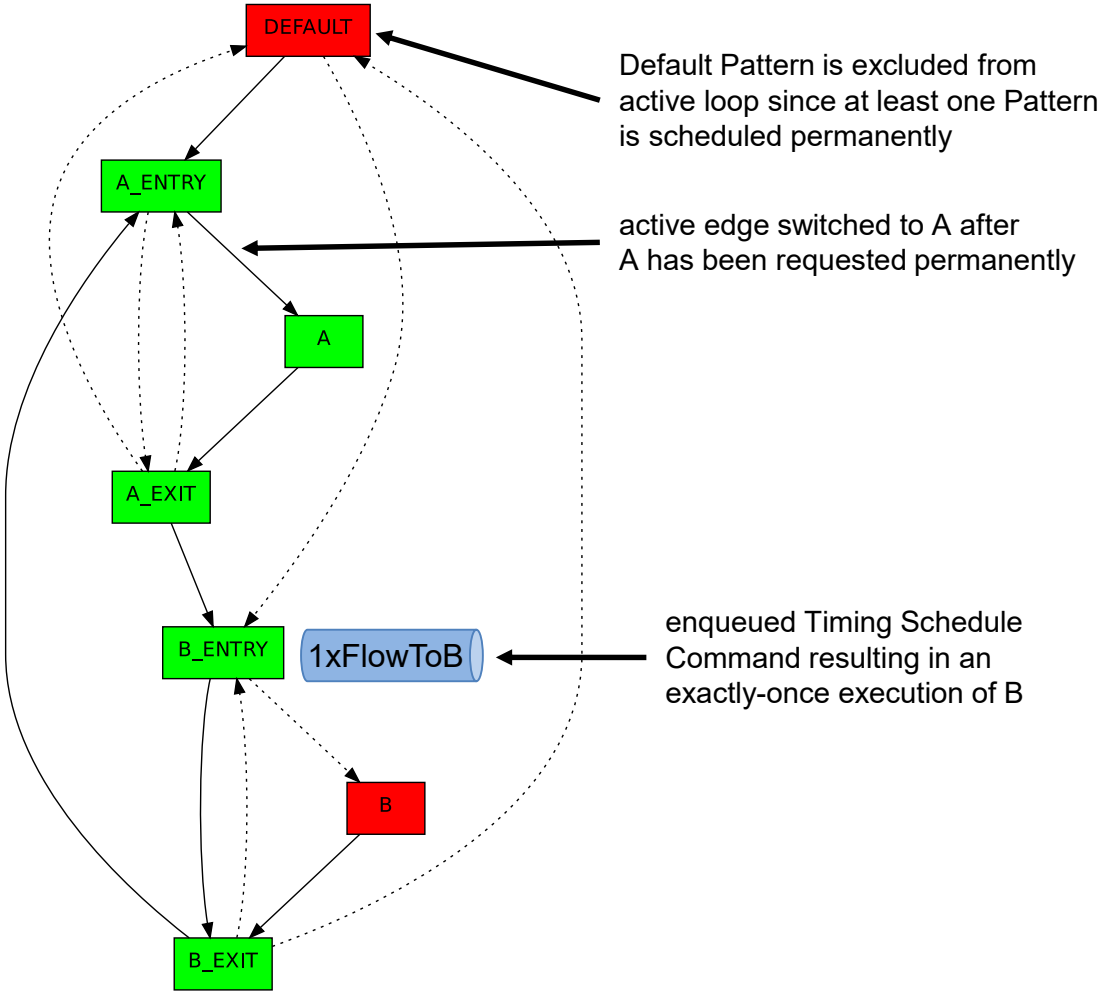

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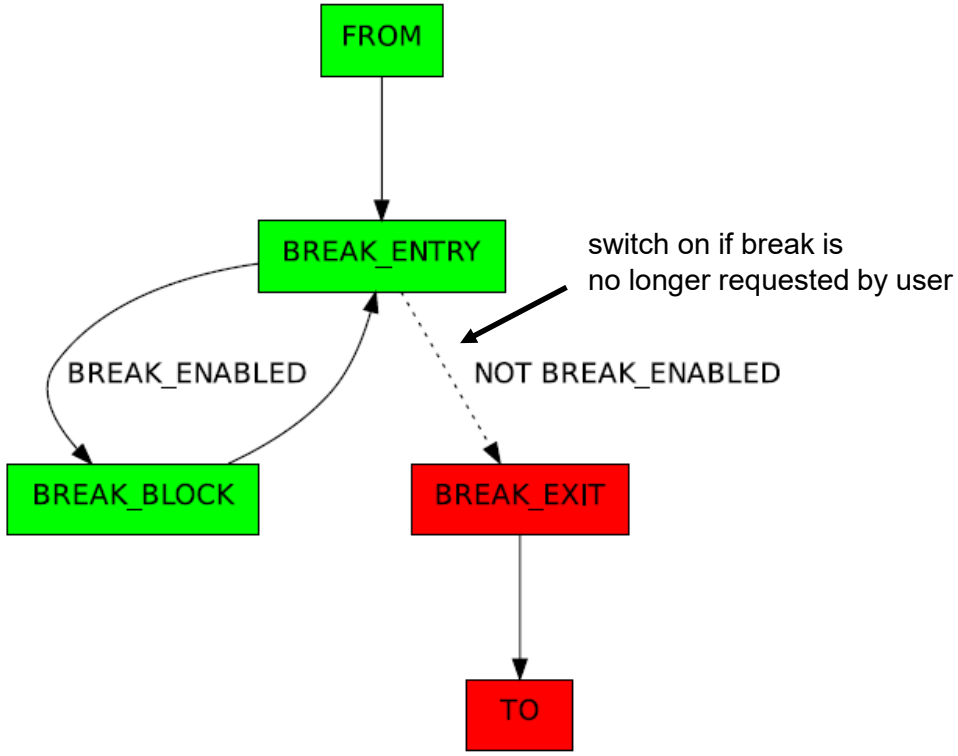

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