November 11, 2010

Innovative Automation Solutions for Open-Pit Mining & Material Handling

Power and productivity for a better world™

Open-Pit Mining & Material Handling

Electrification and automation of mining, conveying and stockpiling machinery

Dragline
Shovel
Stacker / Reclaimer
In-pit Crusher



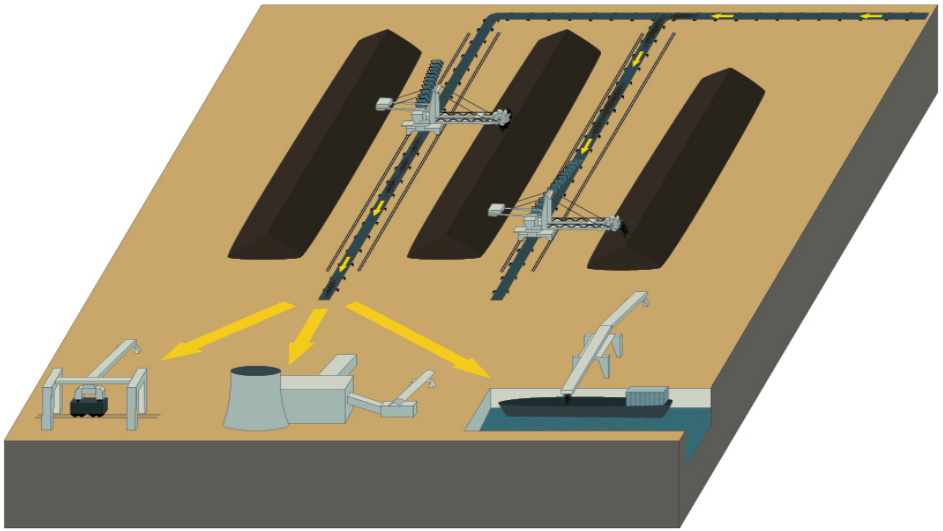
Excavator
Belt conveyor
Spreader



Central Control Rooms
Mine and Stockpile Management


Stockpiles & Terminals – Introduction

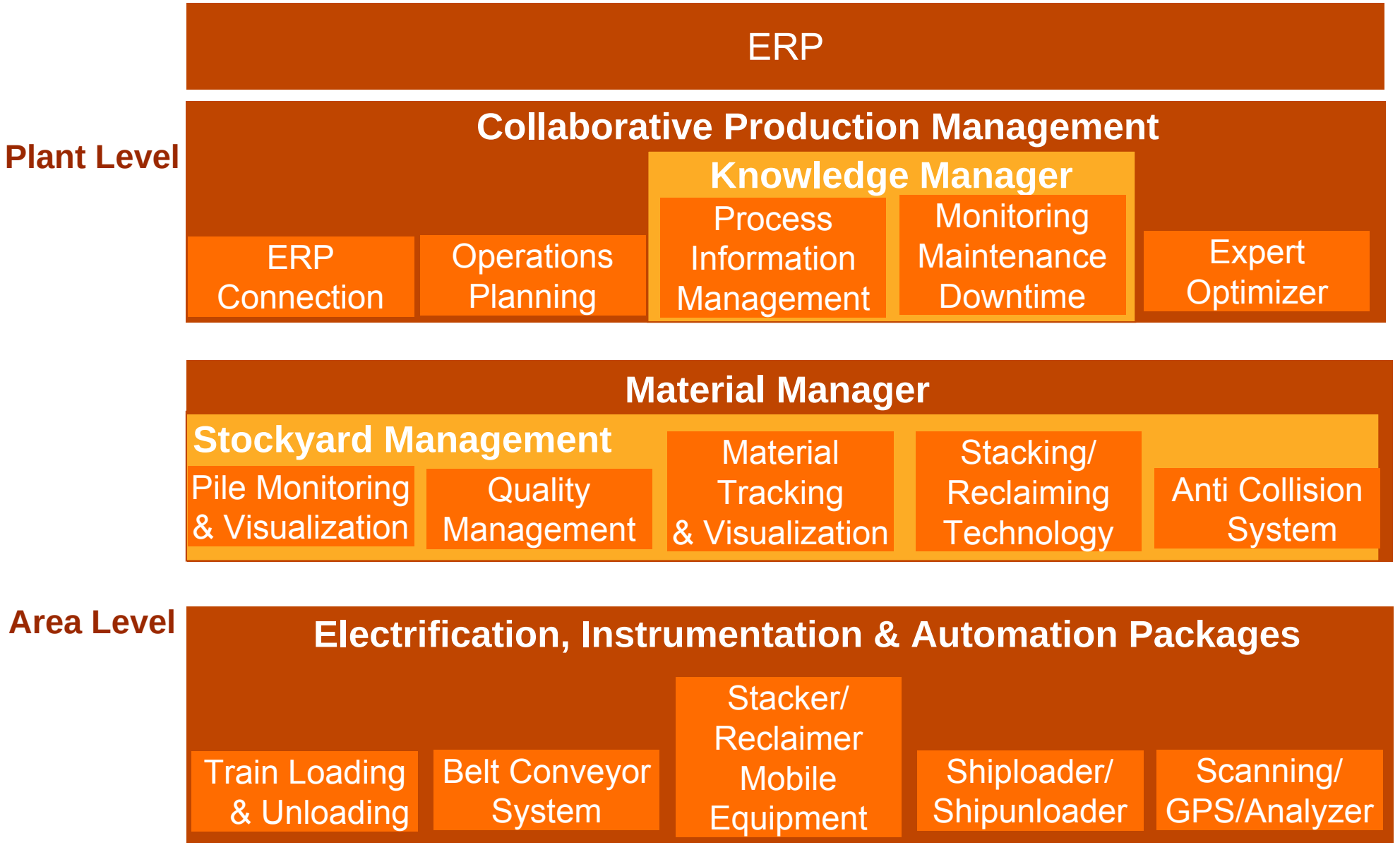
- Various equipment / systems used in material handling
  - Train loader / unloader
  - Ship loader / unloader
  - Belt conveyor
  - Stacker / reclaimer
  - Bulldozers
  - …
- High level of operator support and automation is necessary
  - Increase production efficiency
  - Optimize process output
  - Achieve accurate and transparent input-output balancing



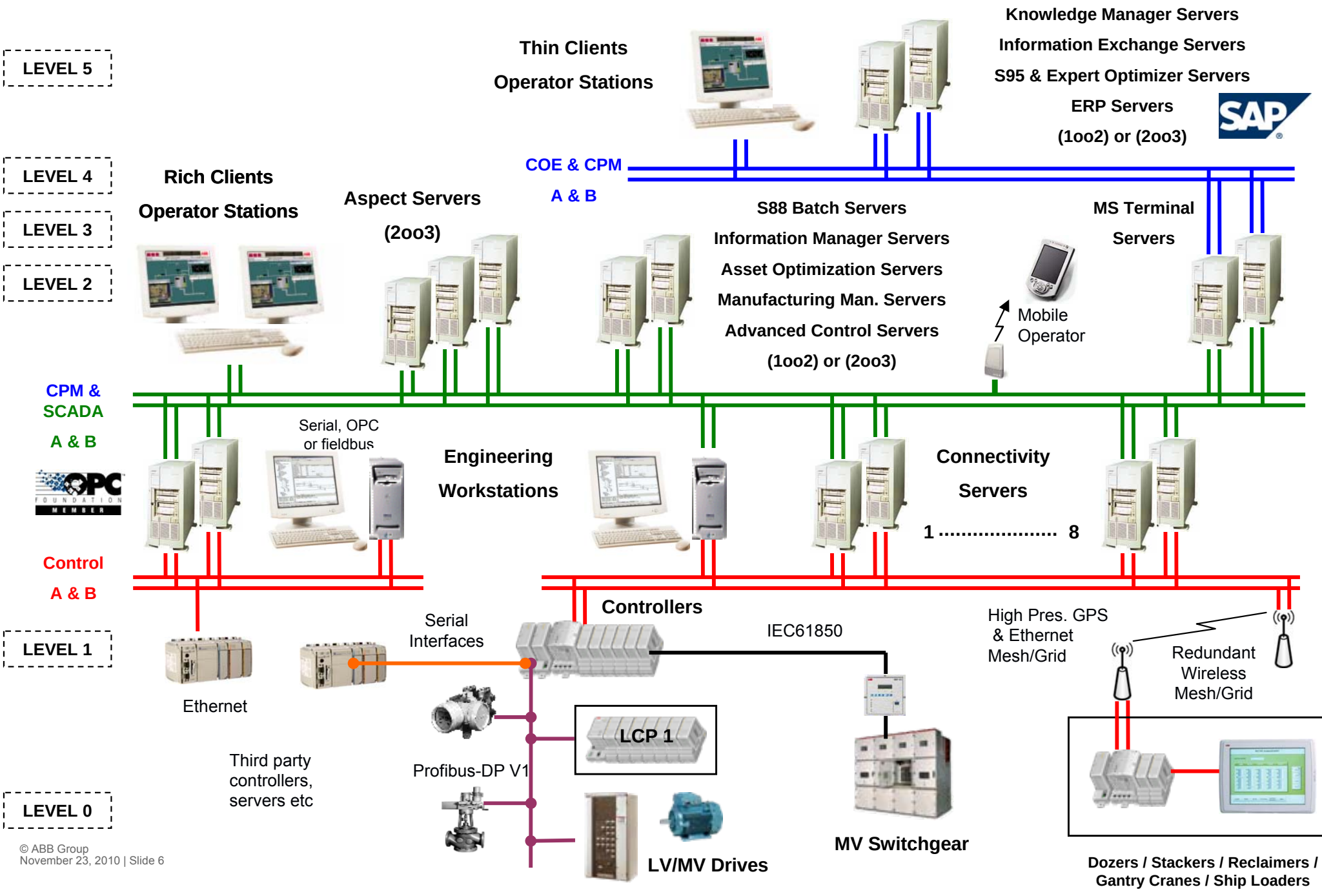
Stockpiles & Terminals – Introduction

- Crucial information: exact distribution of bulk material with the required properties to the scheduled destinations
- Operator personnel needs to know at any time how much material with certain properties / specification is at which location (surge bin, on a belt, stock pile, …)
- Accurate transportation and stockpile model needed within the stockyard management system to monitor real time material flow for tonnage and grade from incoming system to stacking, storing, reclaiming and outgoing system
- Main system components:
  - **Material Tracking and Visualization**
  - **Pile Monitoring and Visualization**
  - **Quality Management**
  - **Stacking/Reclaiming Technology**
- “Anti Collision System” at control level is necessary for safe operation

Stockpiles & Terminals
Integrated solution – Module definition



Control Systems Architecture Levels



Stockyard Management
Common data base for all modules

- Same data base for all modules
- Data configuration only once
- Interface is well defined and based on SOAP/XML
- Two different groups of input information:
  - Input of configuration data
    - Coordinates of belt conveyor tail-, head- and transfer station
    - Coordinates of stock pile areas with capacity and grid measures
    - Number and type of yard and pier machines and their operating range
    - Coordinates and type of mass and volume measurement equipment
  - Input of job data
    - These data can be provided from the higher level module (Expert Optimizer) or manually
    - Selected conveying route for the job
    - TAG of yard machine which delivers the material (wagon unloader, reclaimer at the beginning of the route) and which spreads / stacks the material (stacker, ship loader at the end of the route)
    - Start and stop position for new job
    - Properties (kind and sort) of material to be transported like sulfur, ash, BTU of coal, grade of iron ore, size and consistence of pellets
    - Owner, origin and final destination of material
    - Expected / planned tonnage

Stockyard Management
Common data base for all modules

Example of SOAP/XML config data interface to graphic engine

- GetDevices
- GetPreferedQualities
- GetPreferedQuality
- GetQualityDefinitions
- GetQualityItemDefinitions
- GetRails
- GetReservation
- GetReservations
- GetStackingmethodDefinitions
- GetStockpile
- GetStockpileBase
- GetStockpileContent
- GetStockpileJobContent
- GetStockpileProfile
- GetStockpiles

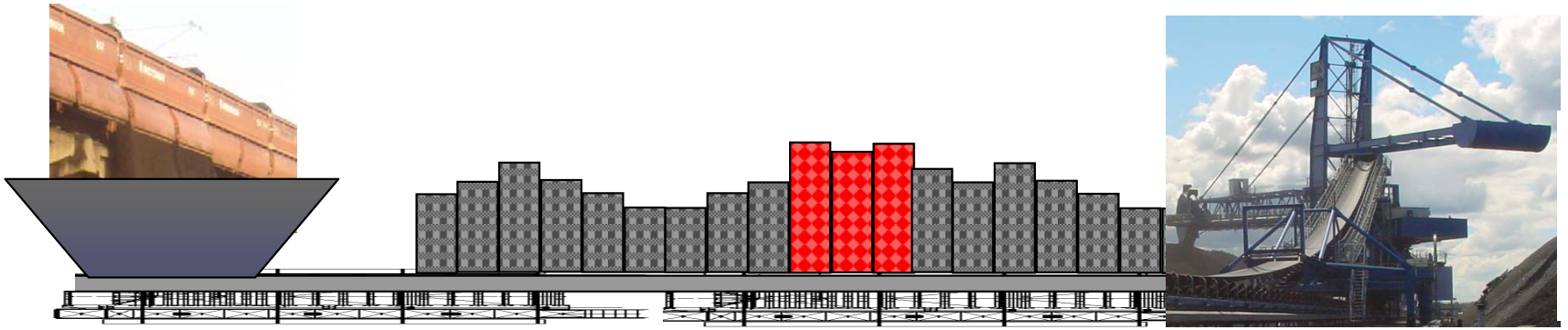
The following is a sample SOAP 1.2 request and response. The **placeholders** shown need to be replaced with actual values.

```
POST /Service.asmx HTTP/1.1
Host: 192.168.3.46
Content-Type: application/soap+xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap12:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3
  <soap12:Body>
    <GetStockpile xmlns="http://stockpilemodel.api">
      <id>
        <id>long</id>
      </id>
    </GetStockpile>
  </soap12:Body>
</soap12:Envelope>
```

```
HTTP/1.1 200 OK
Content-Type: application/soap+xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap12:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3
  <soap12:Body>
    <GetStockpileResponse xmlns="http://stockpilemodel.api">
      <GetStockpileResult>
        <id>
          <id>long</id>
        </id>
        <geometry>
          <area>
            <width>int</width>
            <length>int</length>
          </area>
          <position>
            <x>int</x>
            <y>int</y>
            <h>int</h>
          </position>
          <alpha>int</alpha>
        </geometry>
        <info>
          <name>string</name>
          <description>string</description>
        </info>
      </GetStockpileResult>
    </GetStockpileResponse>
  </soap12:Body>
</soap12:Envelope>
```

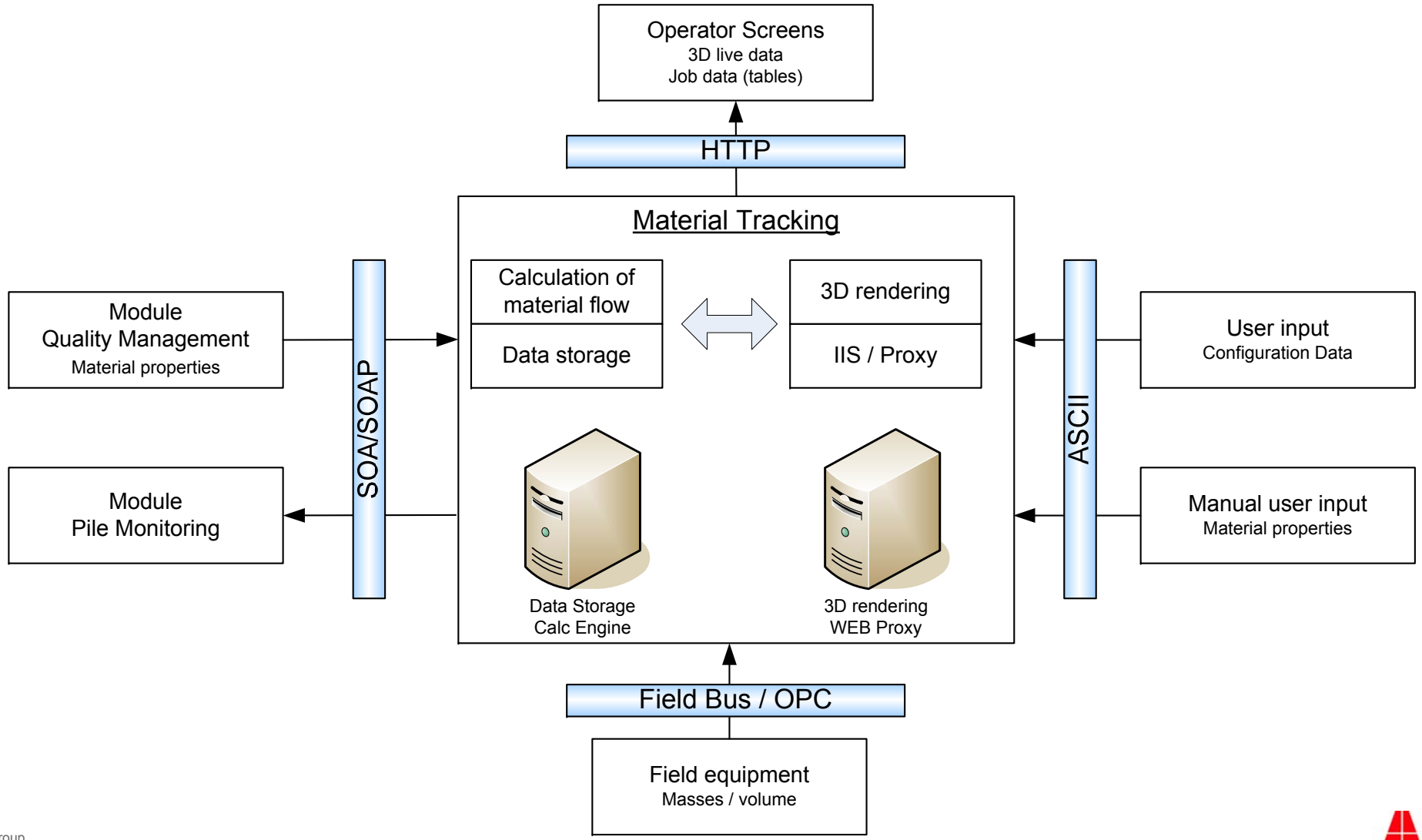
Material Tracking

- Support for the operator to monitor the material flow of bulk material
- Provides real time stockpile tracking by tonnage and grade
- Main functions:
  - Hand-over of delivered material type and its specifications in preferably electronic form or by manual entry
  - Monitoring of masses/volumes on belt conveyors
  - Tracking of materials to the discharge point
  - Dynamic display of belt load with color differentiation according material type and alerts for belt overload
  - Balances of input, stored and output material mass / volume
  - Data exchange to higher level and parallel modules and systems

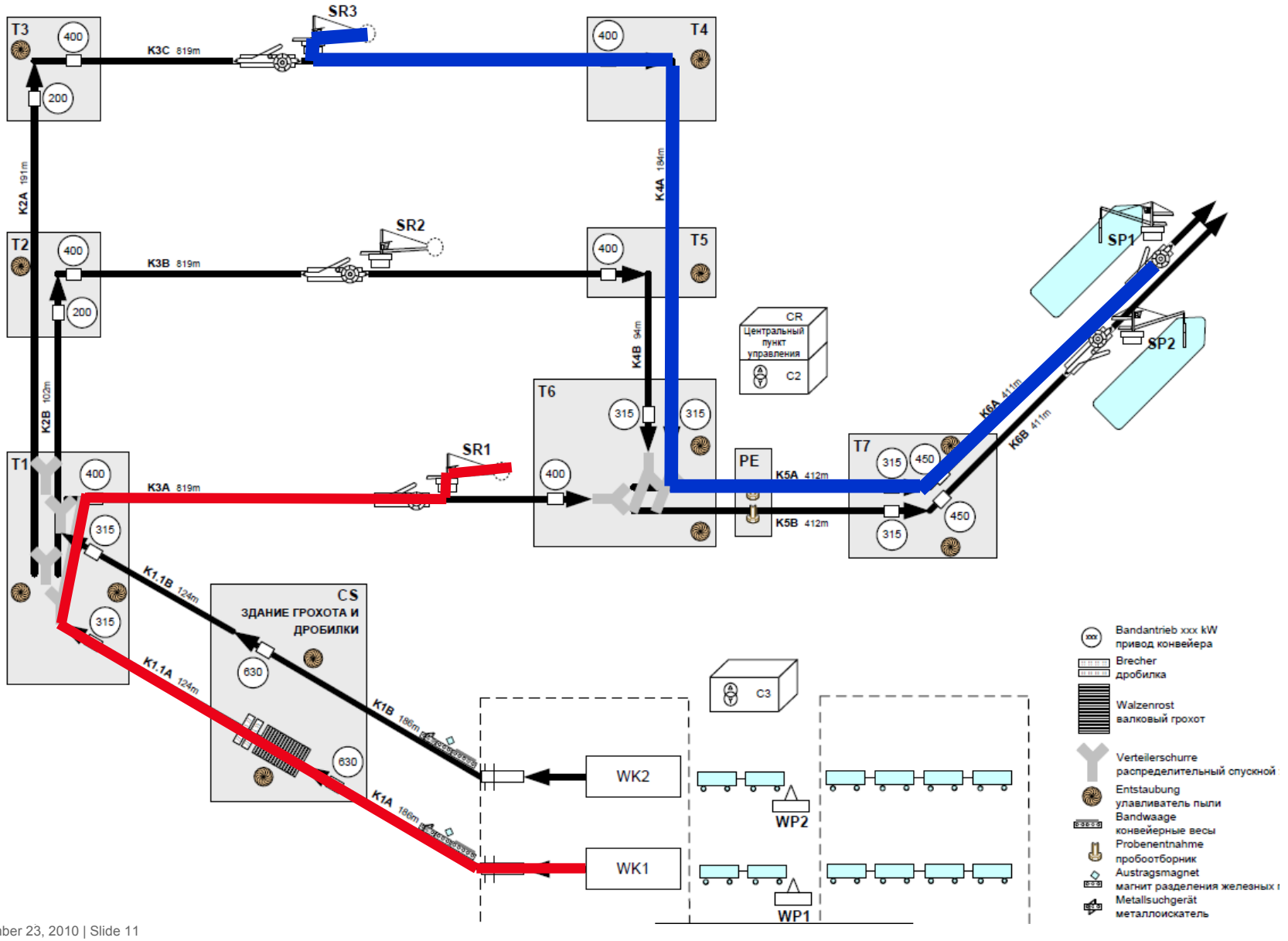


Material Tracking – System Structure

The system structure shows the data exchange to and from parallel and/or higher level systems



Material Tracking - Definition of Planed Conveying Route

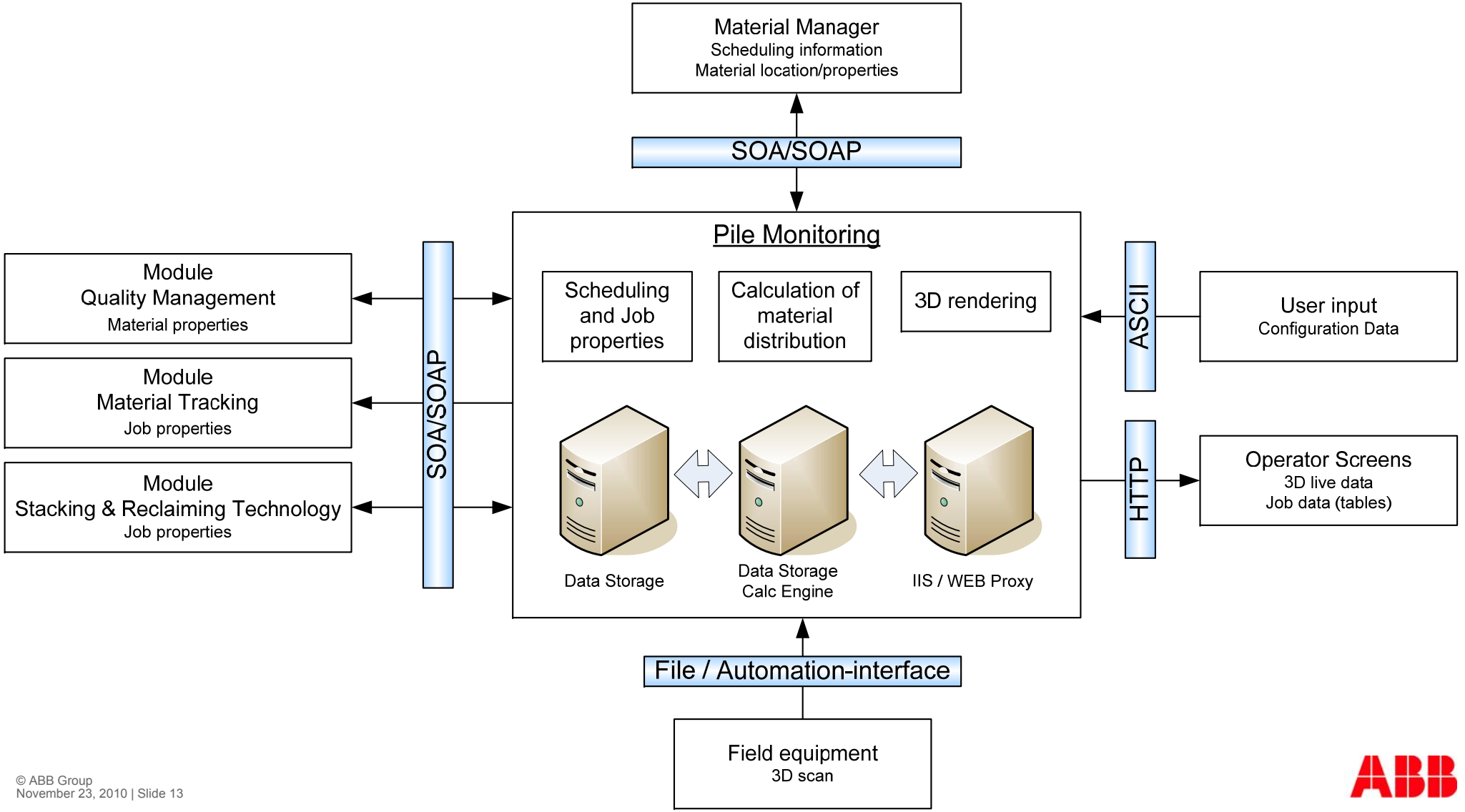


Pile Monitoring & Visualization

- Records material flow to and from a stockpile and calculates the material distribution on a stockpile accordingly
- Tracked data supplied by module “Material Tracking”. Material distribution on the stockpile is calculated with a computational model of stacking and reclaiming processes.
- Provides information about the material on the stockpile and enables detailed analysis of the internal structure and composition of stockpiles and stockyards
- Historical data of all material shipments are recorded and can be accessed at any time. Information is available about how long on which stockpile the material was stored, which origin the material had and if applicable which destination.
- Stockpile visualization offers a graphical presentation of the information stored in the stockyard management system. The stockyard can be displayed in 2D or 3D view with modern browser technology. For a detailed analysis of the stockyard it is possible to zoom and pan the view.

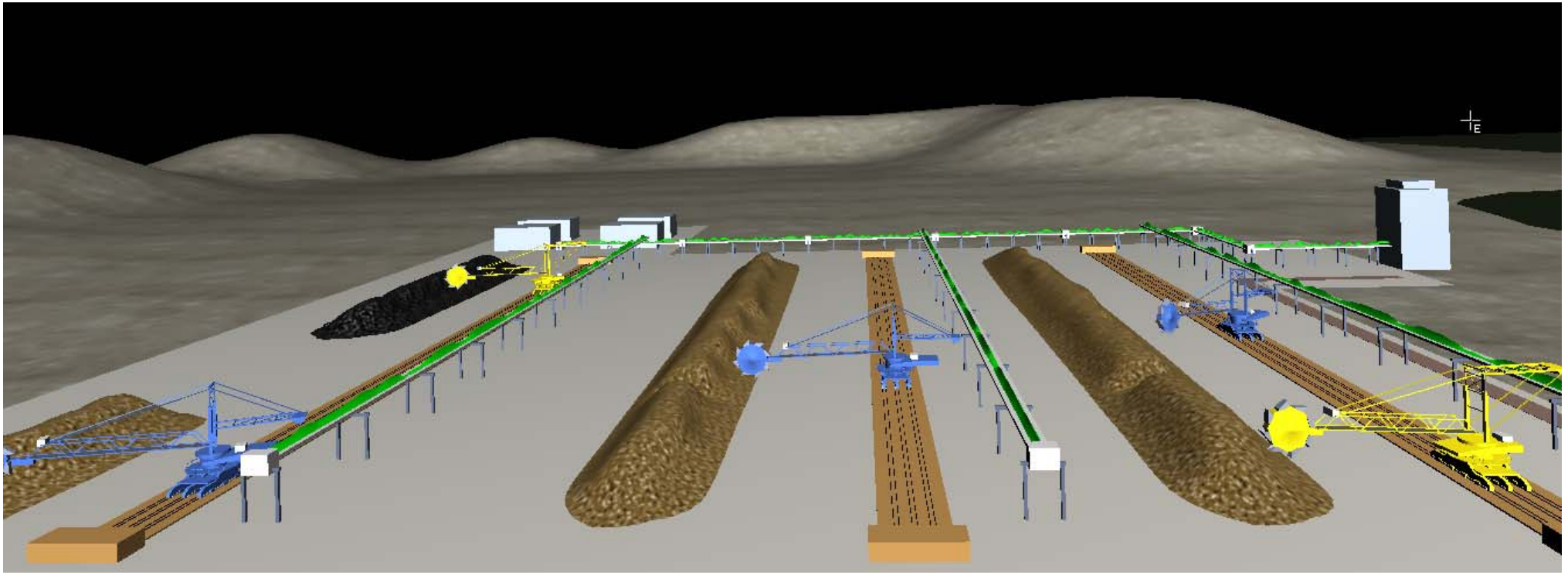
Pile Monitoring & Visualization

The system structure shows the data exchange to and from parallel and/or higher level systems



Pile Monitoring & Visualization

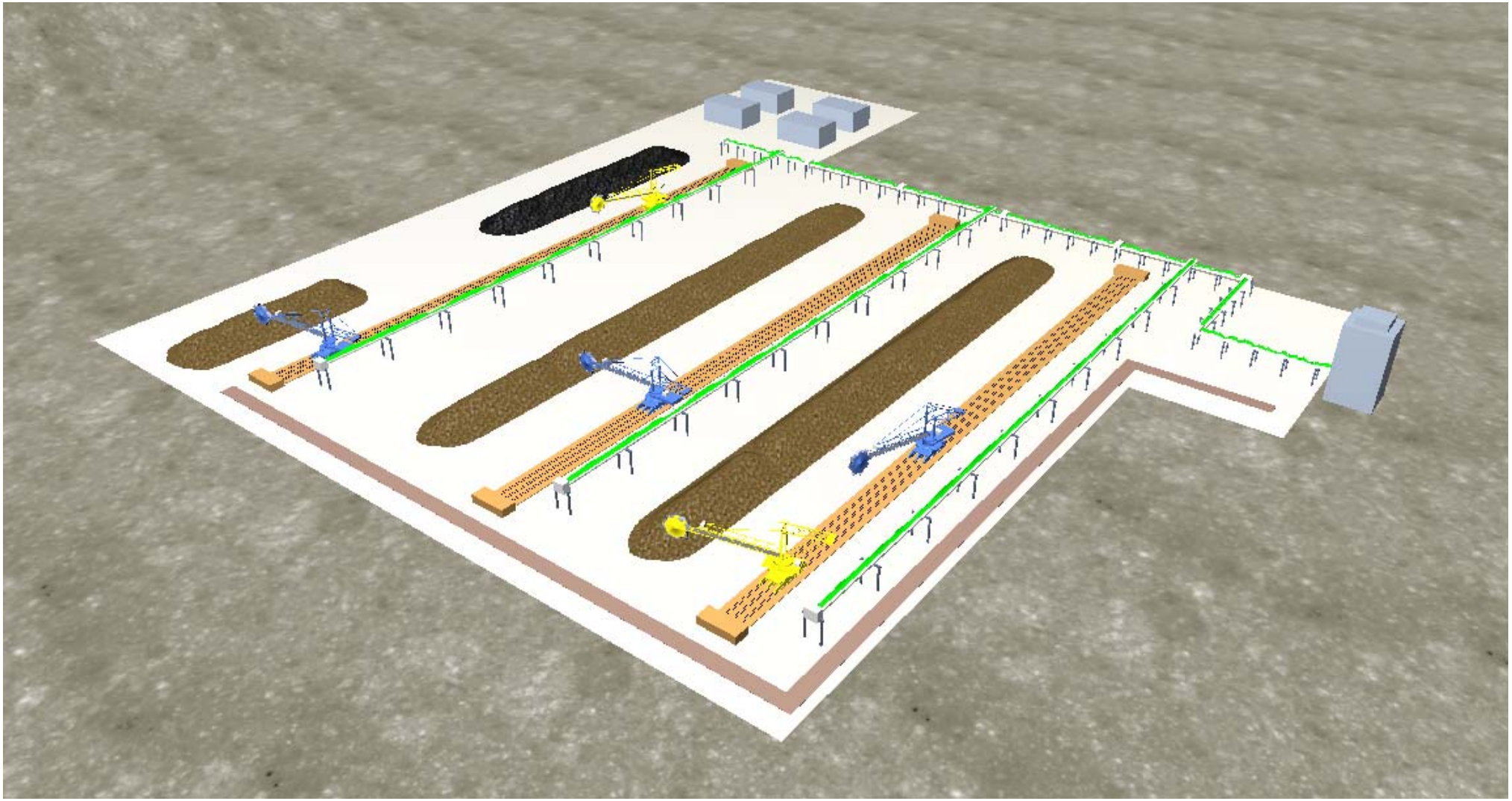
3D visualization of pile shape with different views – here with 4 stockpiles, bird watch, views of underneath and fly overs of stockpiles



- Additional functions:
  - Activation of predefined view points, allows the view from all edges and side ways
  - Selection of individual piles
  - Internal block structures are visualized in contours, cross-section, long-section, quality/grade
  - Pop ups appears while moving the mouse over the pile section to display additional information and properties

Pile Monitoring & Visualization

3D visualization of pile shape with different views – zoom in and out



Quality Management

- „Quality Management“ module is a required to handle material specifications and material properties in all other modules with following main features:
  - Takes over information from mine planning and geological modeling systems or directly from transport group (train, ship, …)
  - Shows actual and forecast (planed) material movements
  - Laboratory system integration for automated data collection
  - Shows material origin and material owner
  - Qualities will be stored block wise for each transported material block, starting at the receiving chute of a belt conveyor, along the belt conveyor until it was spread onto the pile or loaded on a train/ship

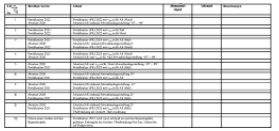
Quality Management

Data transfer from train dispatch system

- **Number of wagons**
- **Tonnage per wagon and total tonnage**
- **Quality and other properties**

To Quality management in form of

- **Lists (manually)**



- **RFID**

- **Barcode**

- **Defined data interface (SOAP / XML)**

Stacking / Reclaiming Technologies

Depending on pile architecture and blending requirements

- Mechanical machine construction / design is different
- Different operation technologies can be used

In case of standard Stacker and Reclaimer or combined Stacker/Reclaimer the following technologies are common:

Reclaiming:

- Long travel reclaiming
- Bench or block reclaiming

Plus technologies with:

- Drum or Bridge Reclaimer
- Portal Reclaimer (Scraper)

Stacking:

- Windrow Method
- Chevron Method
- Coneshell Method
- Strata Method
- Block stacking

Stacking / Reclaiming technologies

Most yard machines run with local operators

- Allows good monitoring of stacking/reclaiming operation
- Level of education and experience influence machine performance
- Operation, production level and wear of equipment sometimes not satisfactory

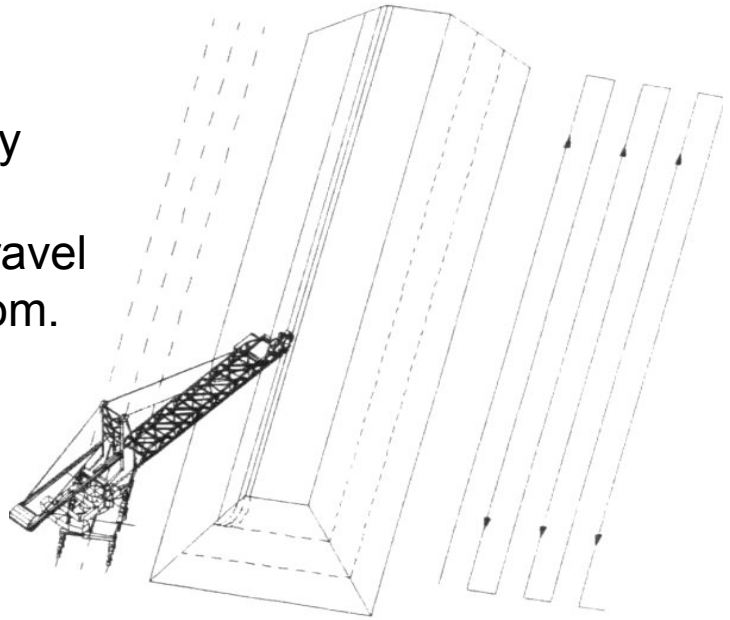
Manless machine operation / full automatic mode is a better option

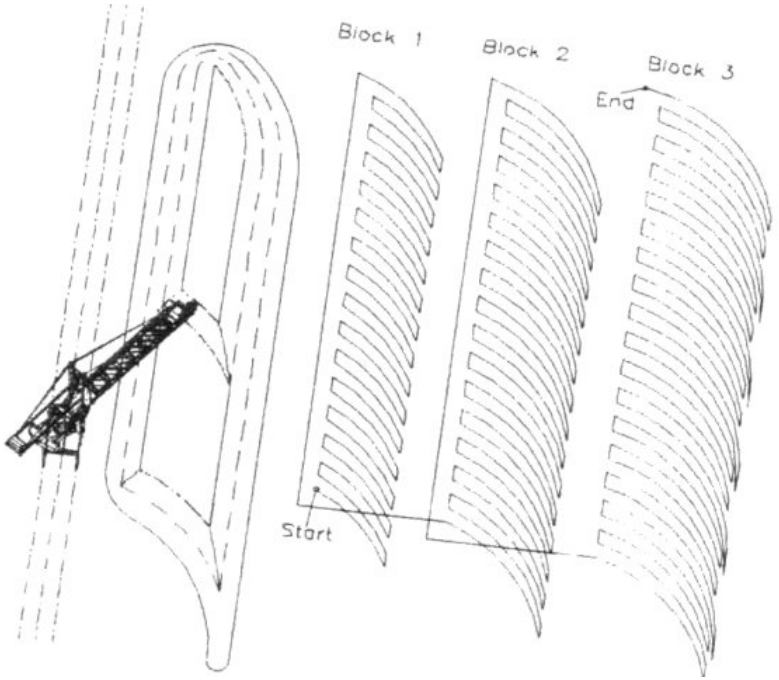
- Yard machines run remotely controlled by one operator in a central control room
- With necessary field devices to measure the pile shape and to prevent collisions the equipment can run continuously. This means:
  - Constant and optimized belt load resulting in optimized material throughput
  - Less equipment wear due to reduced stress factors (no system overload)
  - Less faults and damages triggered by operator failures
  - Cost savings due to reduced number of operators

Reclaiming technologies

Long travel reclaiming

In long travel operation, cutting is performed by travelling the whole reclaimer alongside the stockpile. The cutting depth is set after each travel movement by advancing the bucket wheel boom.





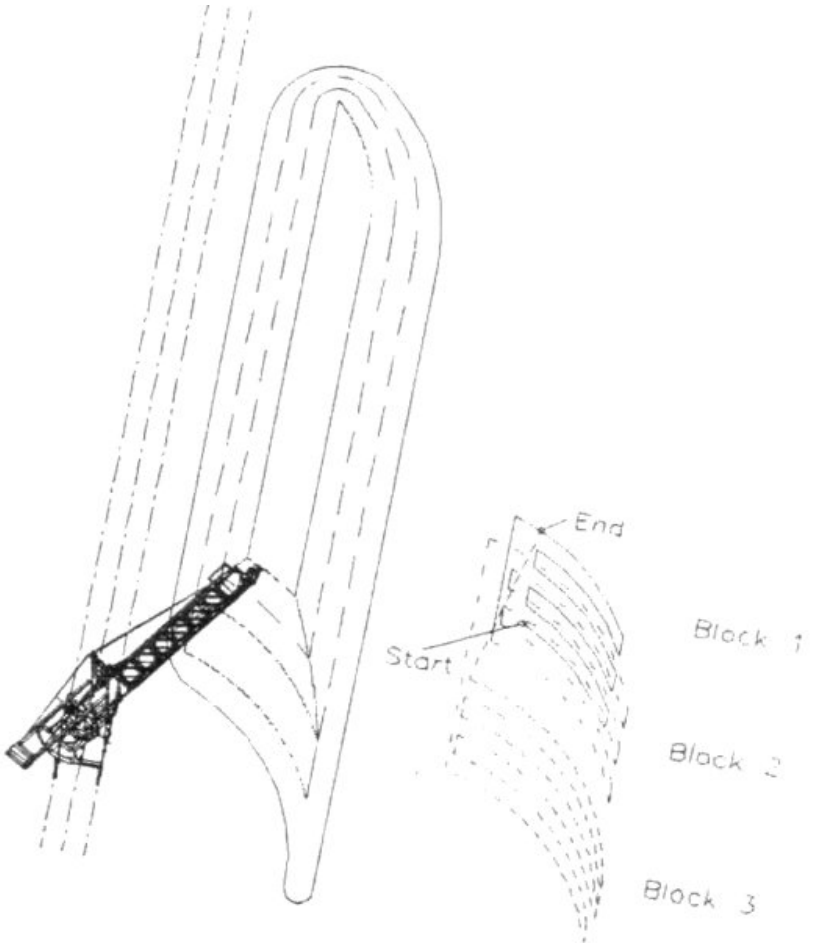
Bench or block reclaiming

In slew operation, the pile is reclaimed in benches by slewing the boom. After completion of each individual slewing movement the machine is advanced for the new cutting depth.
On block reclaiming, the stockpile is reclaimed in benches over a specified length.

Reclaiming technologies

Pilgrim step reclaiming

The pilgrim step reclaiming is in principle built up on block reclaiming. However, in order to be able to reclaim the pile completely, a number of the travel advances have to be defined. The number of travel advances should be an even number in order to ensure that return travel takes place in a safe area of the pile.
After new positioning, reclaiming can be resumed at the lowest block height.



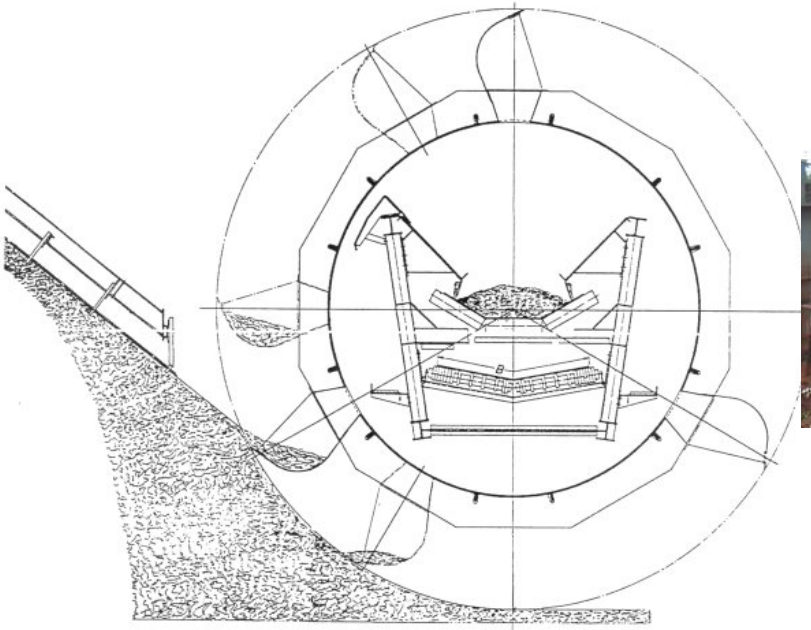
For all methods is important:

Slewing and lifting/lowering operations have to be performed during traveling to reduce operating times with low or zero load and to optimize operating efficiency.

Reclaiming technologies

Drum or Bridge Reclaimer

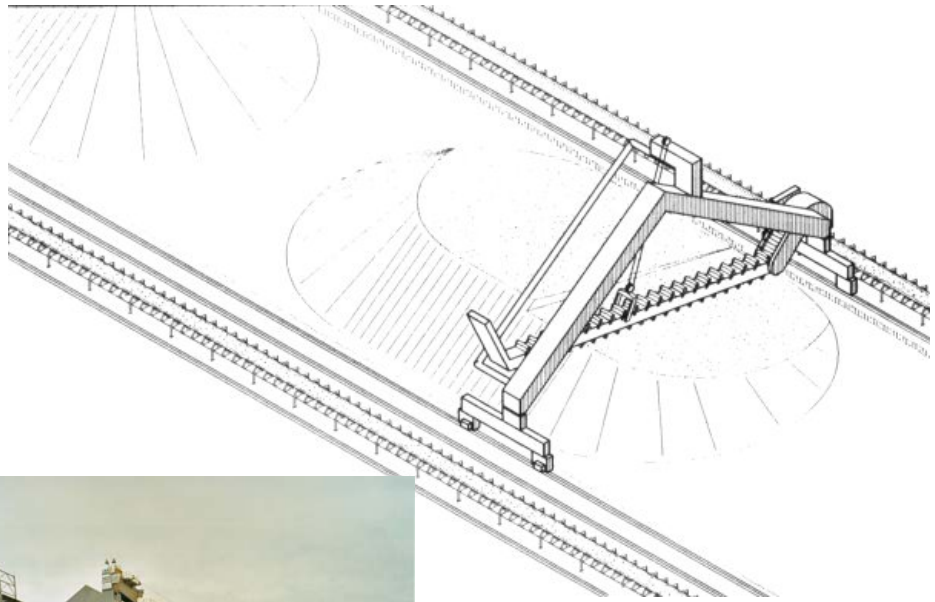
During reclaiming the drum reclaimer travels at a controlled speed in the direction of the stockpile. The adjustable harrow retains the full face of the stockpile at an angle slightly shallower than the natural angle of withdrawal of the material being reclaimed. In this way the harrow induces the material to flow down the face of the stockpile in a controlled way into the approaching bucket without avalanching. As the buckets rotate they are in turn filled and discharge their contents gently into the cross conveyor feed chute.

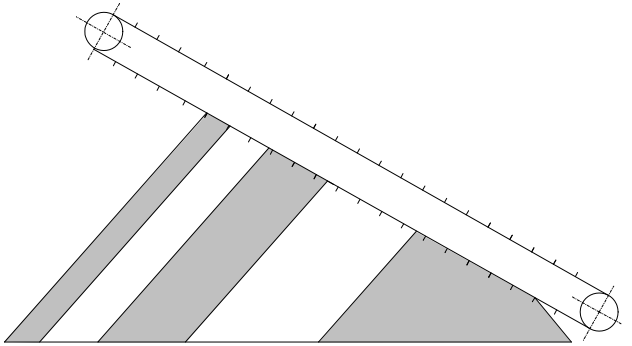


Reclaiming technologies

Portal Reclaimer (Scraper)

The PORTAL-BRIDGE reclaimer consists of a portalised structure with a liftable boom as for the PORTAL reclaimer. It can therefore operate as a PORTAL reclaimer and reclaim from the side face of the stockpile. As a result all the advantages of a PORTAL reclaimer are provided.

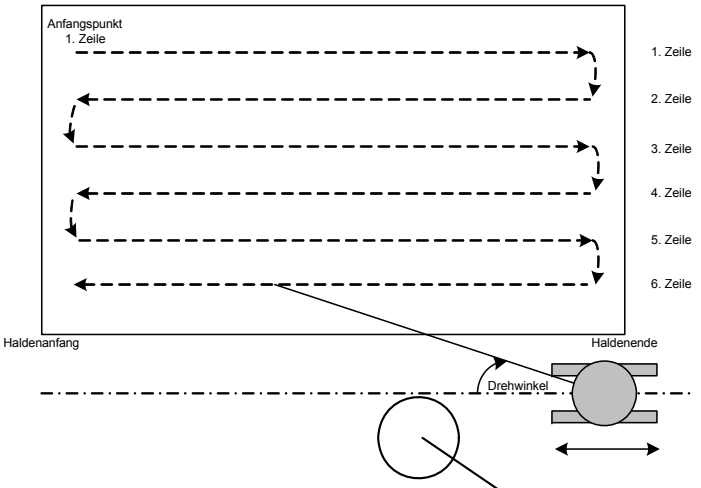




Stacking technologies

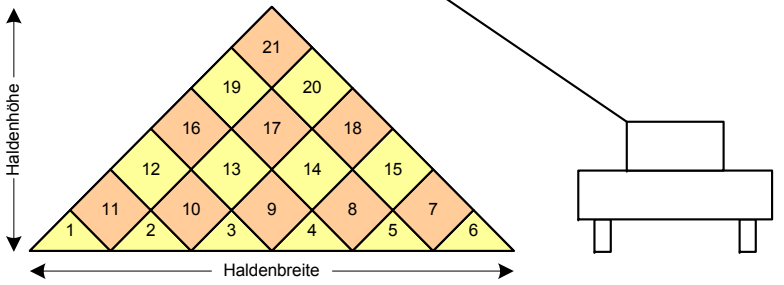
Windrow Method

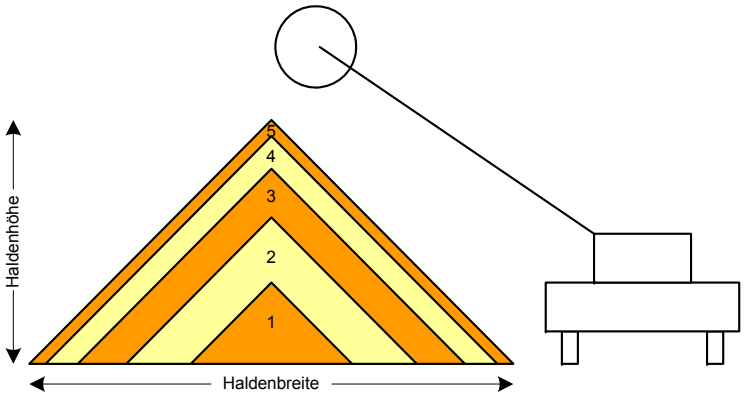
The stacker travels at almost constant speed back and forth along the entire length of the stockpile. It stacks small rips until the required pile height is reached (see sketch)



Chevron Method

The stacker travels at almost constant speed back and forth along the entire length of the stockpile. The boom is raised according to the growth in height of the stockpile. The layer thickness ΔH is reduced as the height of the pile increases.
If reclaiming takes place cross-wise by a bridge scraper reclaimer highest homogenization efficiency can be achieved.

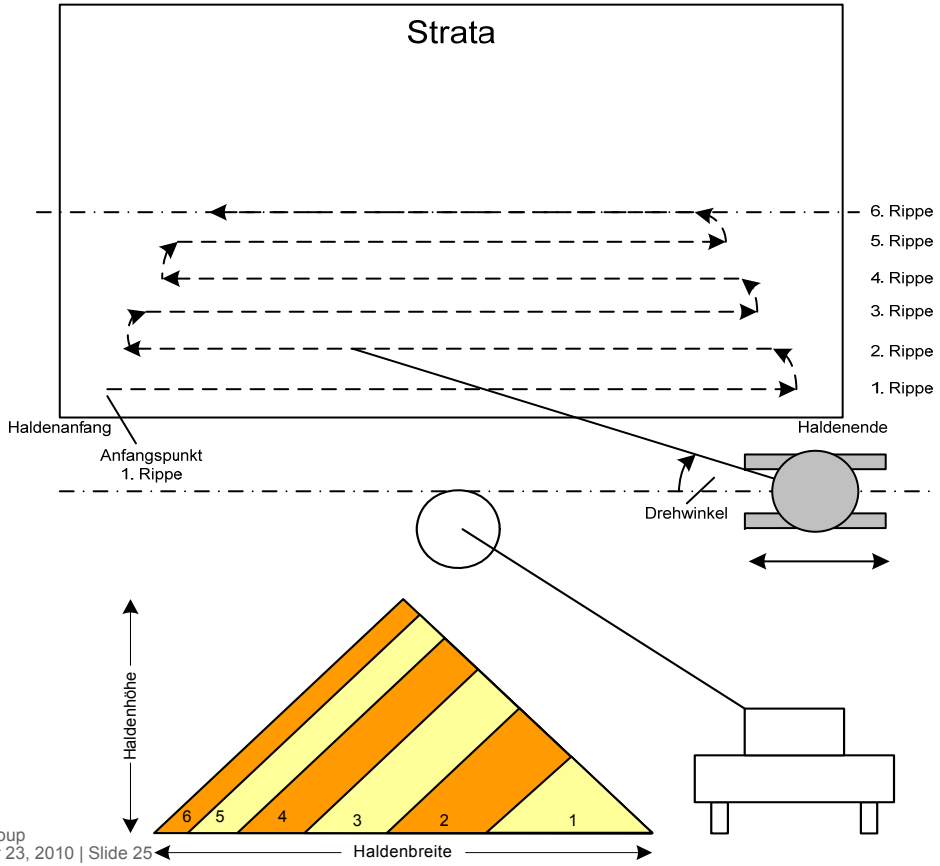


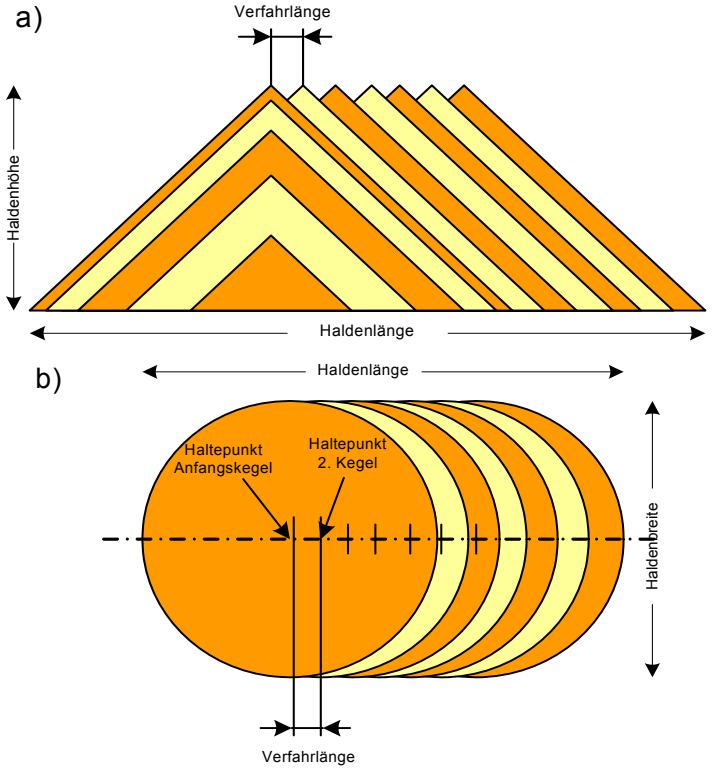


Stacking technologies

Cone Shell Method and Strata Method

The cone shell and strata stacking systems were specially developed for being used in connection with a portal scraper reclaimer. Due to the lateral reclaiming a limited effect of blending can be achieved.

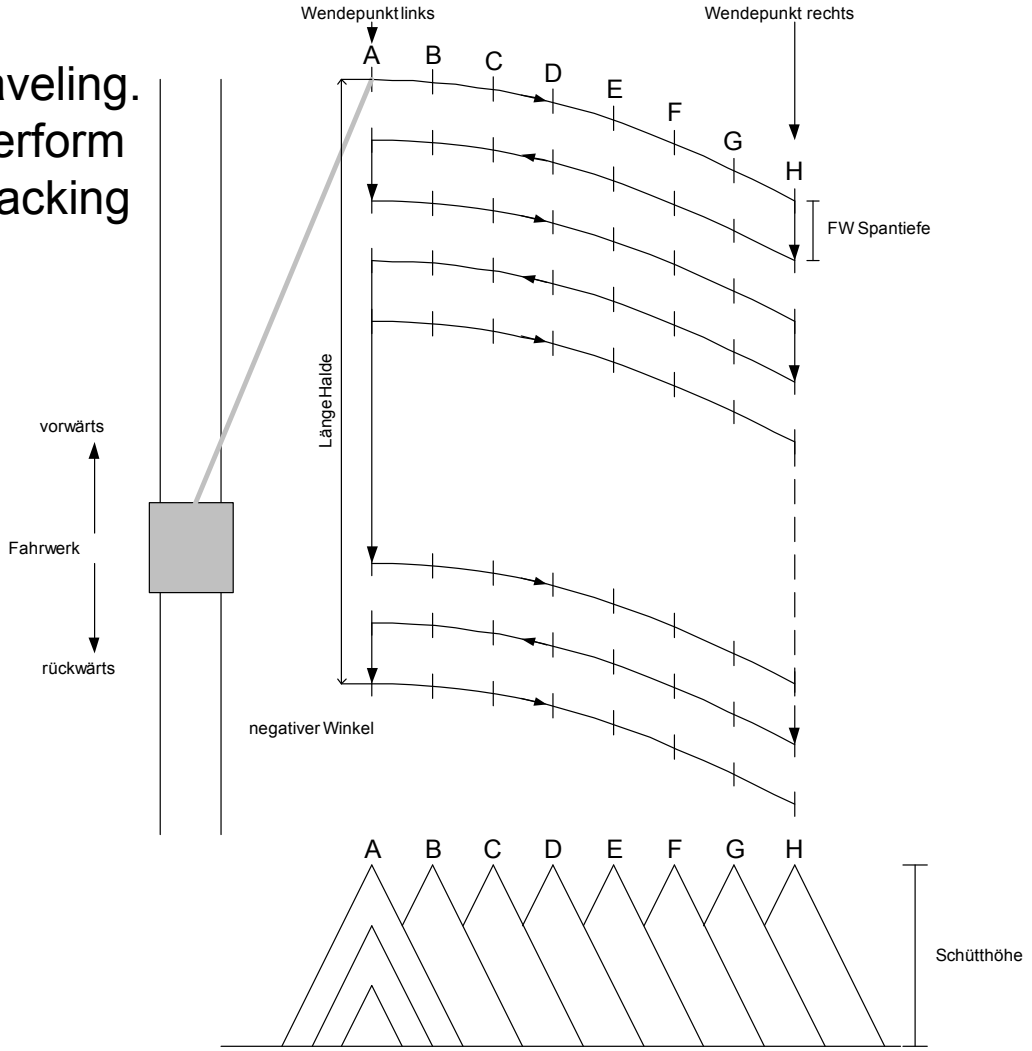




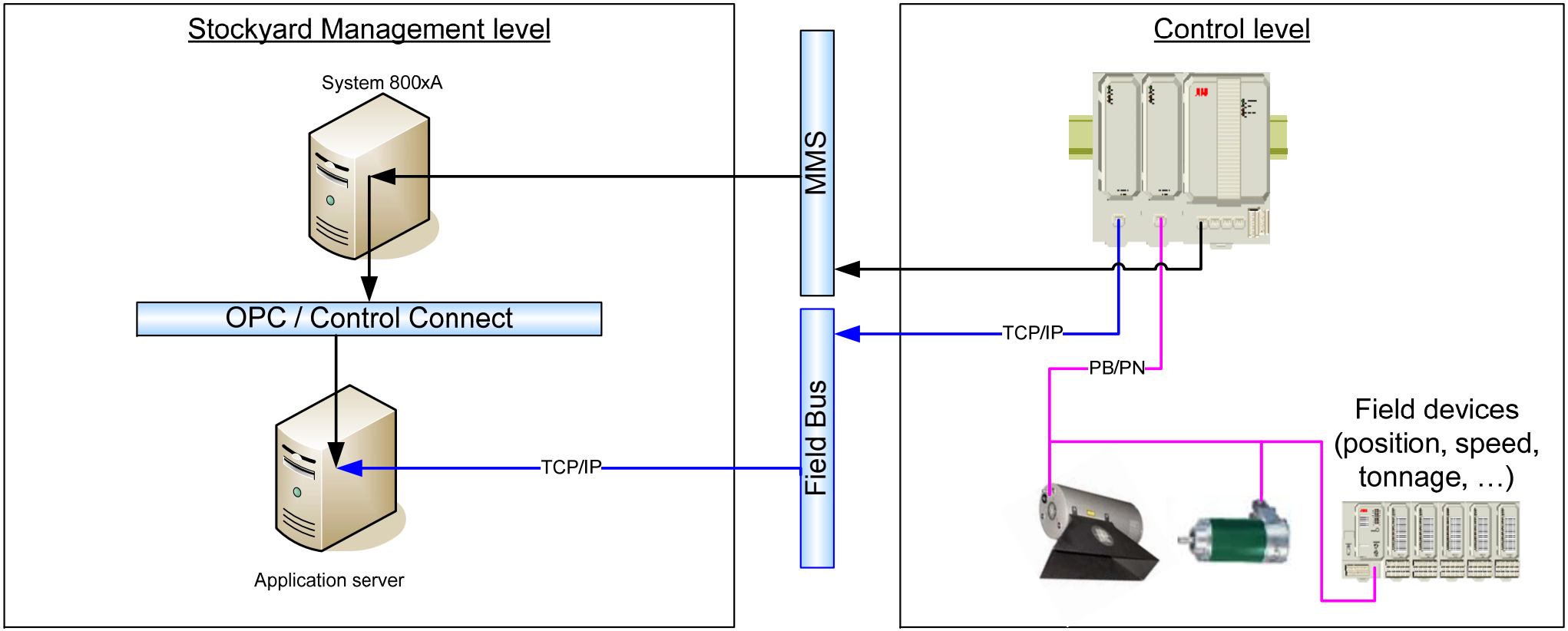
Stacking technologies

Block Stacking

Combination of slewing and traveling. Stacking of a sliced rip, then perform a travel step for or back and stacking of the next rip.



Automation System 800xA Integration
Data interface

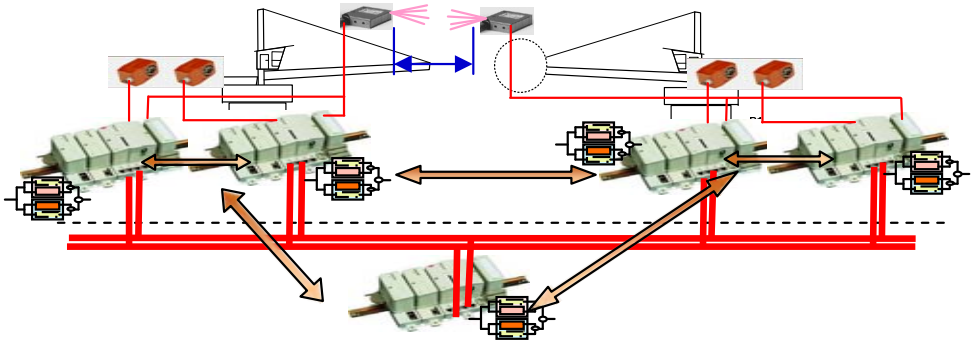


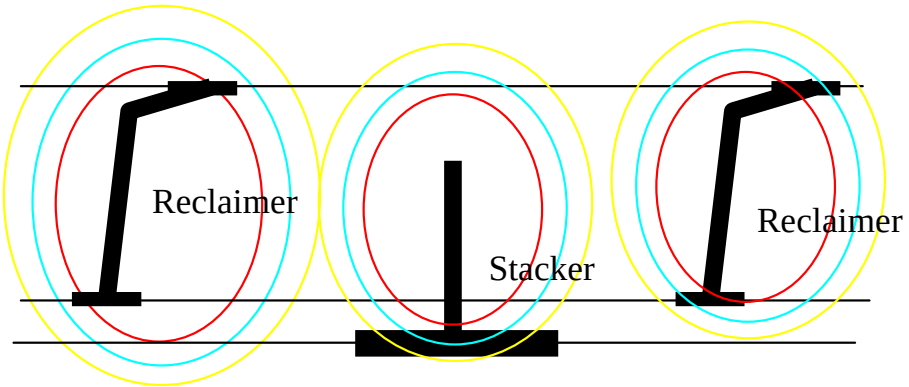
There will be two independent interfaces between control level (yard machines, conveyor). Generally the ABB controller AC800M communicate with system 800xA over MMS. The necessary data exchange to the application server of the modules of the stockyard management system will be performed via OPC or a special control connect.

Fast and time critical data exchange will be performed by a dedicated TCP/IP connection between AC800M and application server.

Manless Operation

- Remote control & operation monitoring
  - Central control room
  - Fibre optic or WLAN data communication
- Risk analysis
- Sensor selection
- Redundancy
- Anti-collision system / collision protection
- Restricted range calculation





Complete Solutions for Ports & Terminals

- Turn-key installations for complete electrification and automation
- Specific solutions
  - Stockpile management
  - Blending
  - On-line analysers
  - Assisted ship loading system
  - Collision avoidance
  - Dozer management
  - Site management
  - ICT solution

Turn-Key Coal Terminal / Port (EC&I)
Case study: Wanino / Russia

- Wanino Port, Siberia, Russia
- OEM: Takraf GmbH Leipzig, Germany
  End user: Daltransugol SUEK, Russia
- Commissioning in 2009
- <u>Mechanical performance data:</u>
  - 1 crusher
  - 3 stockpile machines
  - 2 ship loaders
  - 15 conveyors
  - engineered capacity up to 3.500t/h
  - total trans-shipment capacity 12mt/y
  - temperatures up to -40°C
- <u>Scope of ABB:</u>
  - Plant overview / energy distribution
  - Medium voltage
  - Low voltage
  - Control system
  - Frequency converters
  - Local service
  - Transformers
  - E-houses / cabins
  - Sensors
  - Cables and wiring
- <u>Key Features:</u>
  - Central control room with ABB AC 800F controller system
  - ABB ACS 800 technology

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for a better world™