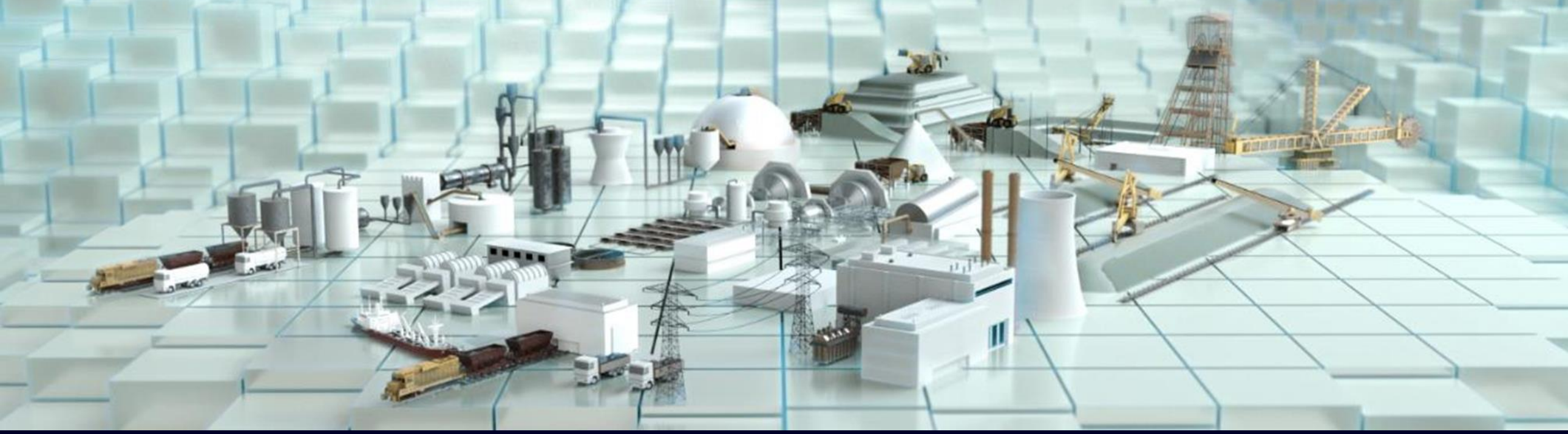

Digitalization in Mining Industry

- Pit to Port Optimization

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Minerals Digital Architecture Concept

Foundation for continuous improvement across the complete lifecycle

Vertical Integration

Corporate Systems

resource planning, supply chain management, sales manager, business intelligence, executive dashboarding and reporting

Enterprise Operations Management

integrated operations center, production planning and monitoring, pit-to-port material management, integrated asset and maintenance management

Mining Operation

asset condition monitoring, process and machine automation, energy monitoring, fleet dispatching, process historian, online ore quality measurement

Enterprise Performance Improvement

predictive decision support and autonomous operation

Operations Management Level

material flow simulation, pit-to-port optimization, short interval control, dynamic planning and execution

Operational Level

process optimization, prescriptive maintenance, asset health analytics, online simulation, autonomous machine operation

Horizontal Integration / Integrated Engineering – Integrated Engineering virtual commissioning long term mine planning

Planning & Engineering → Commissioning & Operation → Improvement → Expansion

SIEMENS

Reference

Vale GPV-M

Development and implementation of the new MES system in all units of iron ore and manganese for 38 sites.

Siemens executed the phases conception, implementation, integrated tests and assisted operation for

- Excavation
- Material Beneficiation
- Material Stock and Shipment

Customer benefits

Integration of existing systems to automate the data extraction and transparent KPIs updated in real time.

Proven Customer value: Saving **US$70 m up to 2020**

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Reference

Advanced Stockyard Management

17 stockyards Morocco wide, 21 reclaimer, 37 stacker, 11 central control rooms

- Real time material inventory
- Driver-/man- less machine operation
- Communication network, CCTV, Condition Monitoring
- Material and quality tracking and monitoring
- Material blending & separation
- Stacking/ reclaiming methods (Coneshell, Chevron…)
- 3D- stockyard model

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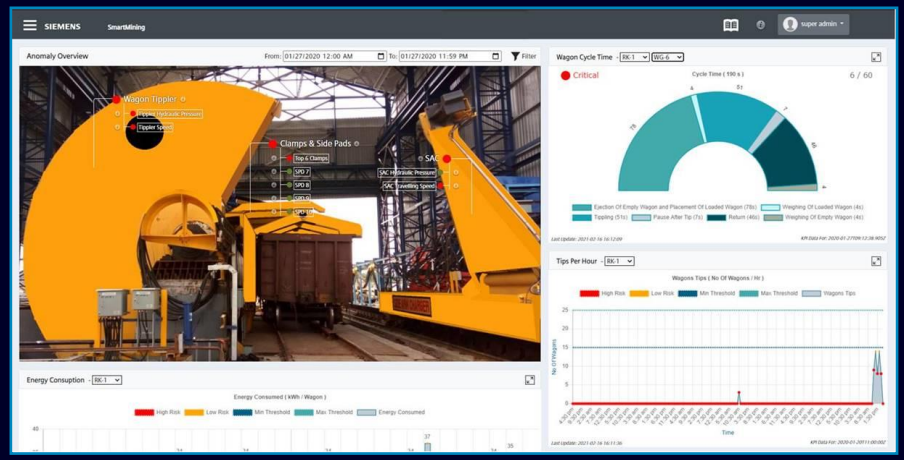
Smart Mining references

AI Wagon Tippler

Utilization of machine learning algorithms for early detection of anomalies and mal-functioning on the tippling operations of wagons e.g. material handover from railway to terminals.



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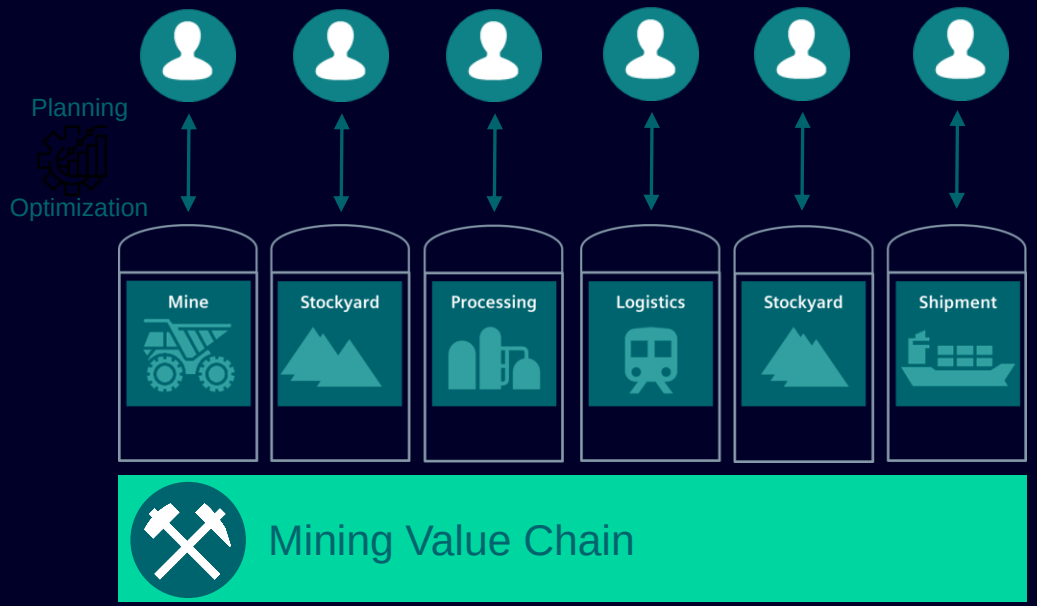
Just-in time Production is Everywhere, BUT not yet in Mining

Current mining operations are managed in silos

- Mining production is decoupled from the purchase order
- Operations are planned individually and are decoupled
- Optimization initiatives focus on individual operations



Current challenges in managing mining operations

Geology uncertainty in deposit affects product quality

Extreme climate conditions lead to short-term production shortage

Challenges of coordinating highly distributed operations make it difficult to meet delivery

Bottlenecks can lead to shortage of supply

Volatility of commodity markets increases the pressure on mining companies to rethink the current management approach

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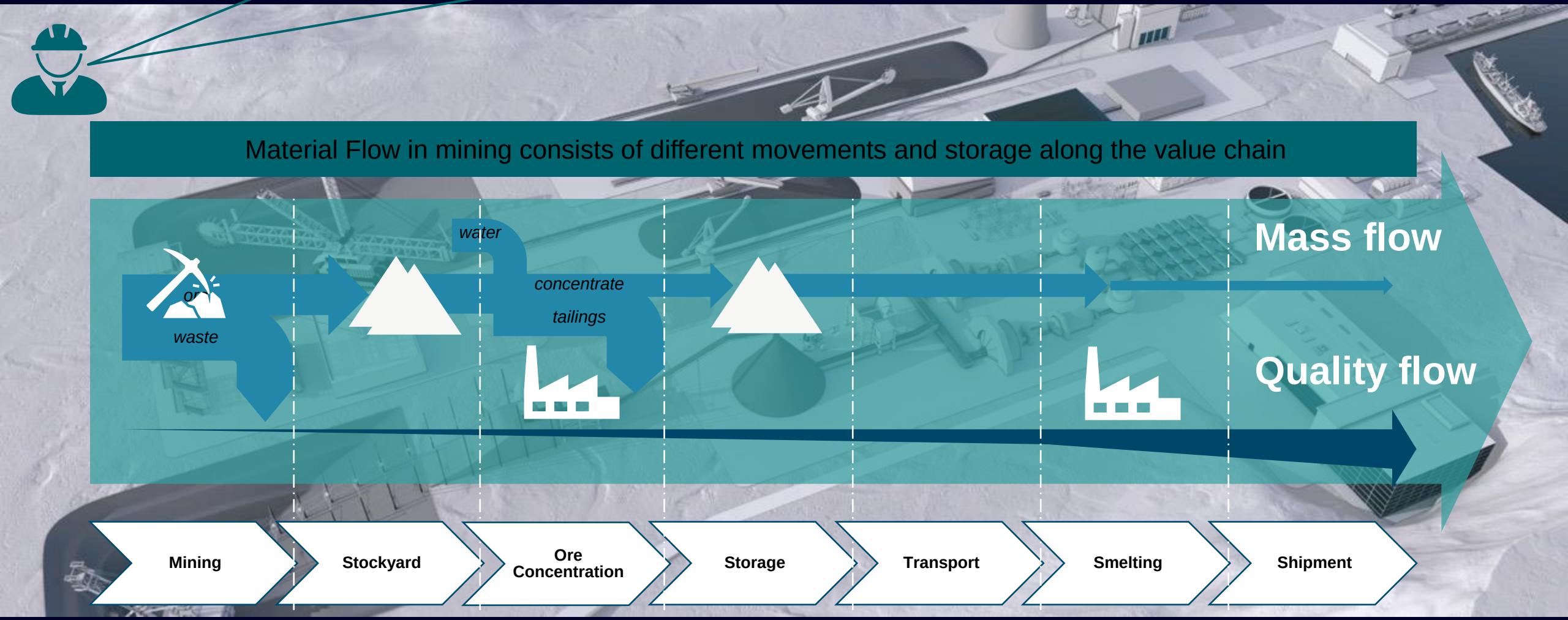
Understanding the material flow is the key to drive efficiency of mining value chain to the next level

Voice of Customer

Material Flow in mining consists of different movements and storage along the value chain



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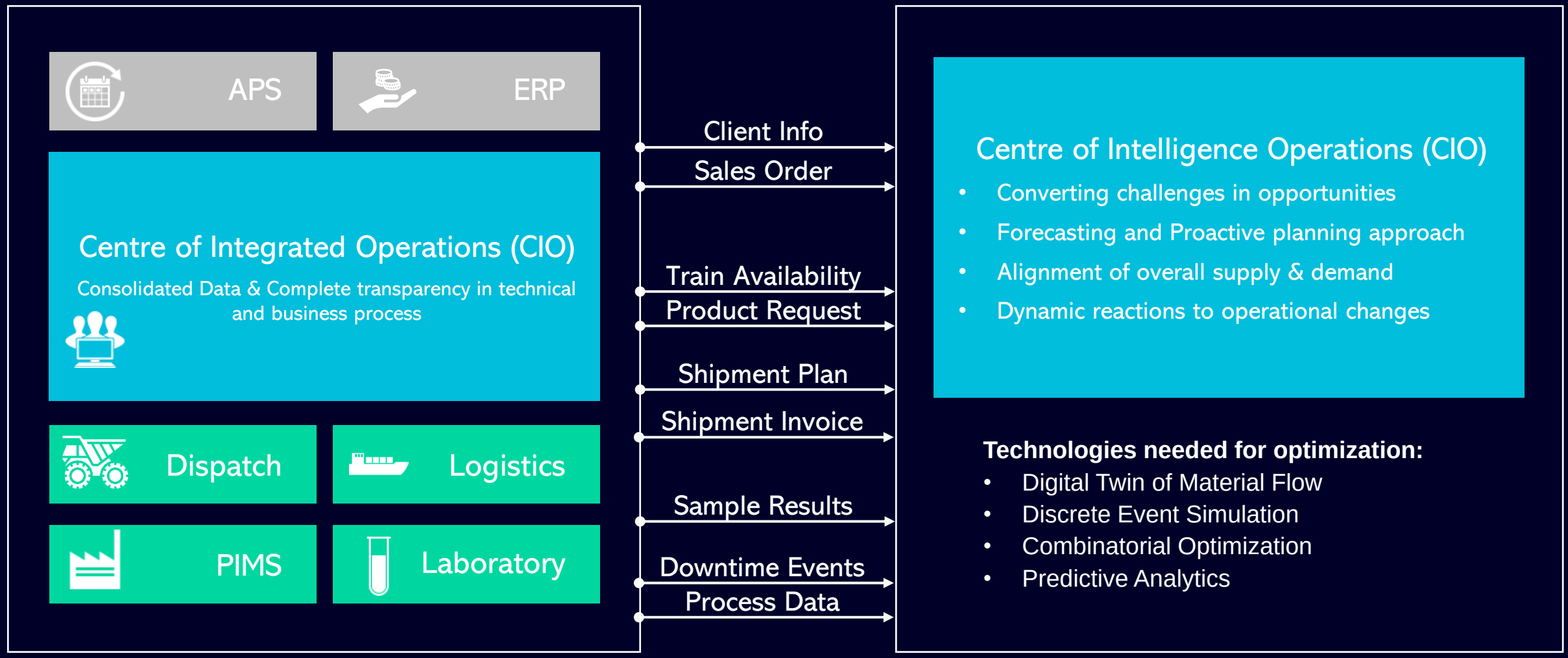
From complete operational transparency to maximize global business excellence



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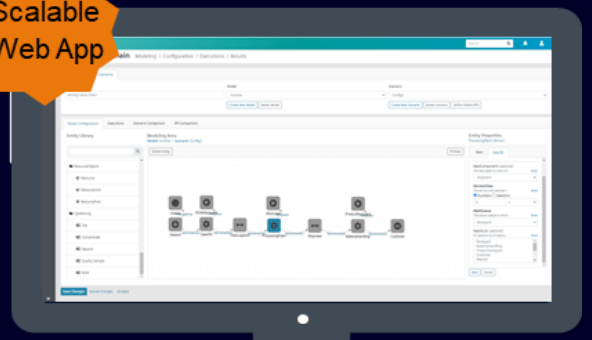
OptiMining Web App empowers miners to leverage optimization potentials along entire value chain

Scalable Web App



Open connectivity

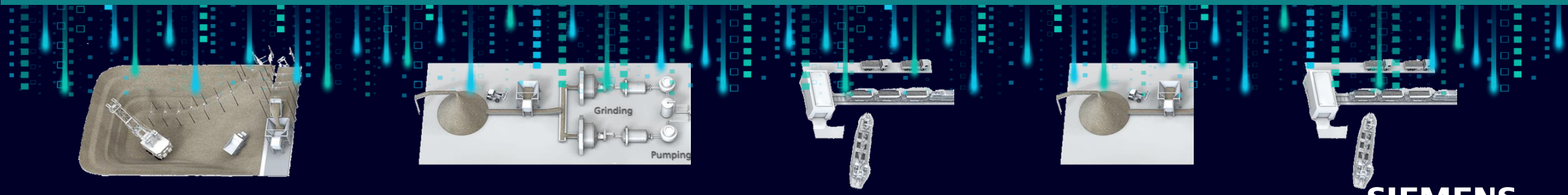
Main Functionalities

Demand driven planning | Virtual test environment | Dynamic scheduling | Inventory forecasting | Shopfloor integration

Potential optimization use cases

- Deposit utilization
- Supply chain mgmt.
- Ore recovery
- Price realization

Operations Monitoring and Management System (e.g. MES, ERP, mine and plant systems)



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Long-term vision: Digitalizing the whole value chain

Central MES providing full transparency along E2E operations

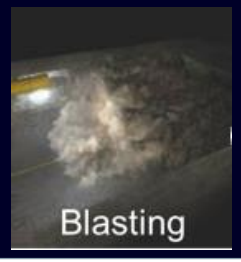
End-to-End Operations Management Solution

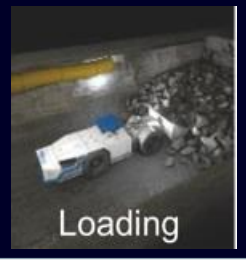
integration of management and production levels, BI functionalities, E2E dashboard, real-time and historic KPIs, planning & scheduling functionalities of operation and maintenance

Material Flow Information Model

Mining | **Supply chain** | **Beneficiation** | **Logistics**

Drilling → Blasting → Loading → Hauling / Hoisting → Crushing → Processing plant → concentrate / waste → transportation → Smelting





- Optimize planning and execution of drilling, blasting, loading, hauling
- Enable real time ore tracking
- Enable personnel and equipment tracking
- Monitoring of production performance to improve decision-making

- Control equipment operability
- Ensure high recovery rate
- Maximize utilization of capacity
- Decrease of OPEX

- ……

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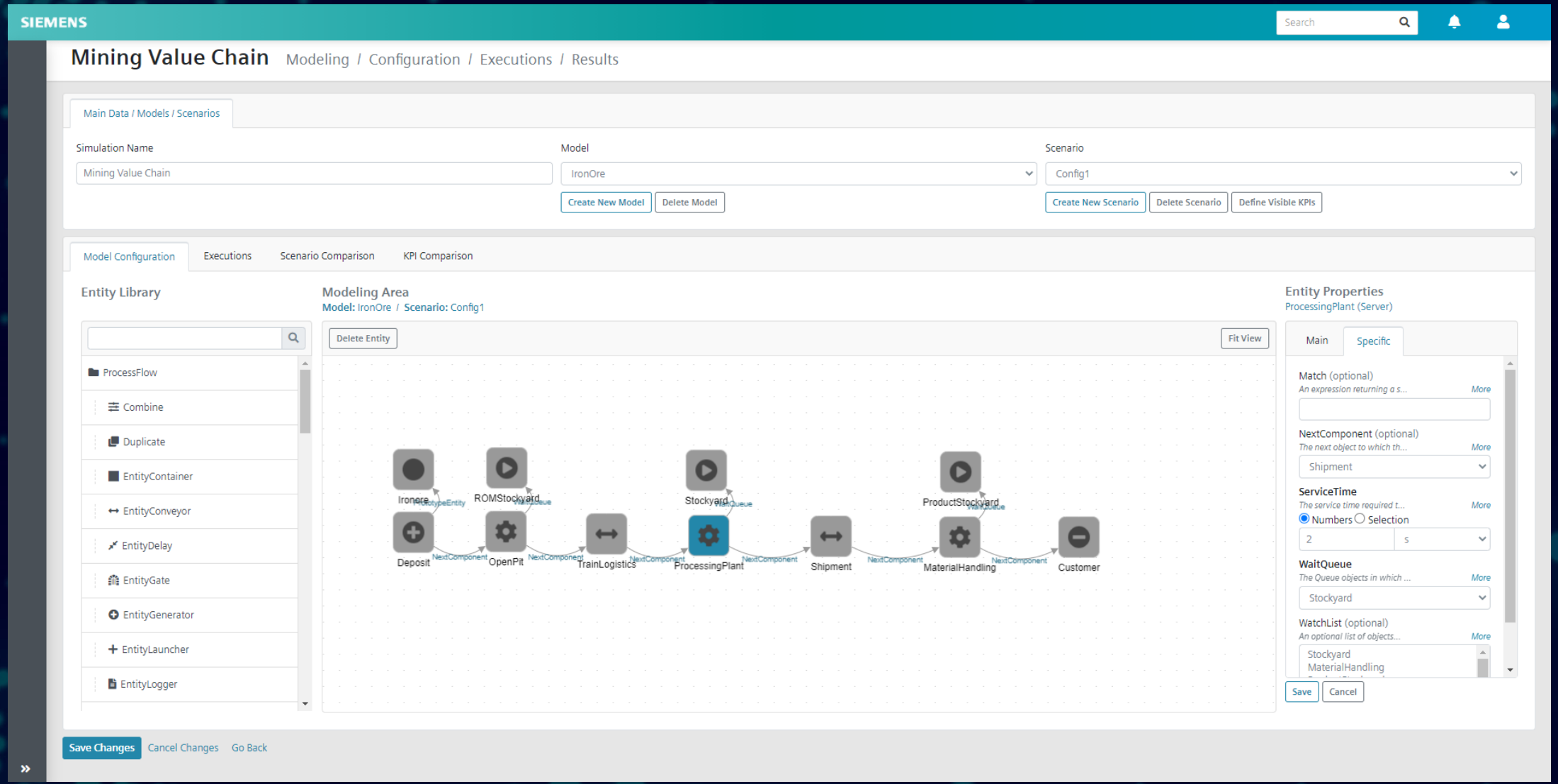
Introducing Centre of Intelligence Operations to the Mining Industry



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