IIoT and Remote O&M in the Chemical Industry

Overview

Supplier Examples

20 Largest Chemical Companies

People, Project, and Plant Data

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McIlvaine Provides Support for Industrial IoT and Remote Monitoring

- McIlvaine's *Industrial IoT and Remote Monitoring* brings together all the supporting information needed to succeed in the rapidly growing IIoT field.
- Many industries are covered in detail in the report but today's Hot Topic Hour will focus on the Chemical Industry.
- Recordings of the industries previously covered are available on our website.
- As you can see in an upcoming slide market forecasts are included for each industry.
- The report is constantly updated to keep subscribers informed of the fast moving developments in the industry.
- IIoW (wisdom) will be an important revenue generator for suppliers. It will boost revenues due to
  - Increased volume and margins
  - New and better products
  - Service revenues

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Overview

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IIoT Empowered by IIoW in the Chemical Industry

- The market for IIoT and Remote O&M for the chemical industry is predicted to rise to $24 billion in 2024 and then to $56 billion by 2030.
- 50 % of the market will represent increased revenues. The other 50% is a shift to IIoT decision makers as opposed to the traditional ones.
- The industrial Internet of Wisdom (IIoW) is needed to empower IIoT.
- An equivalent effort to IIoT requires gathering, standardizing and interconnecting knowledge and people. The successful companies in this new digital environment will be the ones who understand the value of IIoW
- In the chemical industry Mcilvaine is attempting to facilitate IIoW by
  - Compiling data about and communicating the activities of the 20 largest chemical companies
  - Compiling significant IIoT and Remote O&M data about the specific processes, components and software
  - Provide beta examples pursuant to the 4 knowledge needs: Alerts, Answers, Analysis and Advancement
  - Interconnecting suppliers, end users, niche experts, and reduce silos between industries and between divisions in the same company

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IIoT & Remote O&M Chemical Industry
$ billions

World Region	2016	2018	2020	2022	2024	2026	2028	2030
Total	9	12	15	19	24	33	44	56
Africa	0.17	0.23	0.29	0.37	0.46	0.64	0.85	1.08
CIS	0.13	0.18	0.22	0.28	0.36	0.49	0.65	0.83
East Asia	2.86	3.82	4.77	6.04	7.63	10.49	13.99	17.81
Eastern Europe	0.15	0.20	0.25	0.31	0.39	0.54	0.72	0.92
Middle East	0.21	0.29	0.36	0.45	0.57	0.78	1.05	1.33
NAFTA	2.07	2.76	3.45	4.38	5.53	7.60	10.13	12.90
South & Central America	0.79	1.05	1.32	1.67	2.10	2.89	3.86	4.91
West Asia	0.21	0.29	0.36	0.45	0.57	0.78	1.05	1.33
Western Europe	2.39	3.19	3.99	5.05	6.38	8.78	11.70	14.89

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Supplier Examples

Interconnection of suppliers with large end users, with other suppliers and with people in other divisions of the supplier company

Accenture

E+H (in the BASF analysis)
Emerson (Also in the Covestro analysis)
GE
Honeywell
IBM
Linde

Nalco
McKinsey
Microsoft Dynamics
Northwest Analytics
Rockwell
Schneider Electric

Sick
Siemens
Yokogawa

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Accenture Relaunching Best Practices for Chemical Manufacturers

- Accenture and SAP SE plan to expand their collaboration on SAP S/4HANA to develop a digital industry platform that will help chemical companies. SAP S/4HANA Chemicals is a re-launch of SAP Best Practices for Chemicals and SAP Business All-in-One for Chemicals solutions. Optimized to run on the SAP HANA platform and enhanced with SAP Fiori UX, the new solution targets embedded analytics, enabling real-time decision making and predictive simulation capabilities. The solution is expected to be delivered on premise or hosted in the cloud, helping to blueprint a public cloud in the chemical industry, according to SAP.
- “A host of forces are disrupting the chemical industry – geopolitical risks, changing customer desires, growth challenges, population changes, digital technology proliferation and pervasive volatility, to name a few,” says Rachael Bartels, managing director and Chemicals and Natural Resources global industry lead for Accenture. “As chemical industry executives strive for growth in this landscape, new technology can play a major role in unlocking all available value from their processes.”
- Thorsten Wenzel, vice president and global head, Chemicals, SAP SE, says, “More than ever before, market dynamics can jeopardize classical business models, and chemical companies must inspire and shape a digital chemical world in order to pave the way for sustainable growth and outcome-oriented performance.”

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Nexen Chemical, Manitoba Canada using Emerson Delta V

RESULTS

- Increased reliability
- Increased efficiency
- Improved control capabilities
- Reduced operator training cost
- Reduced shutdown/conversion time

APPLICATION The plant makes Sodium Chlorate, a key bleaching agent used largely in the pulp and paper industries.

CHALLENGE Nexen Chemical's Brandon, Manitoba, Canada plant makes about 190,000 tons a year of sodium chlorate. The product's raw materials are salt, water and a lot of electricity. In fact, power is 75% of the variable cost in the process. Manitoba offers North America's lowest electrical power cost. But with no control over that cost, the only way Nexen stays cost-competitive is to control its process more efficiently and reliably. Efficiency improvements in the range of one percent are considered substantial. Making those incremental improvements while maintaining its aging control system was becoming a concern. The Brandon facility's Taylor MOD 300 DCS system was becoming obsolete; replacement components becoming unavailable.

SOLUTION Knowing it had to update, Nexen selected Emerson DeltaV™, citing capabilities like connectivity to fieldbus and DeviceNet digital bus technologies. But Nexen couldn't afford a lengthy shutdown to transition the plant's 1200 I/O from the old control system to the new. So to make the transition within the shortest possible shutdown window, Nexen looked to Emerson's sales representative office, Controltech Inc. of Winnipeg, for a creative–yet solid–solution.

Controltech pre-connected and tested all the termination panels off-line before installation, keeping the MOD 300 I/O intact to avoid rewiring the instruments. Says Nexen's computer high voltage specialist Bob McManus, "The conversion project to the DeltaV system was designed so that we could pre-test the complete software package and the complete hardware equipment before we shut down the one DCS system and started up the new one. That gave us a degree of confidence in our conversion."

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Blaser uses GE Software for Process Improvements

- Blaser Swisslube AG has been producing and selling cooling lubricant worldwide for 70 years. Cooling lubricant, which is used in the metalworking industry, has played a significant role in the history of the business.
- The company implemented GE software to support individual production steps that make up the complex production of cooling lubricant. It generally consists of four basic processes: dosing, agitating, heating and circulating. The solution delivers powerful visualization, data management, and web access to all historical and online data globally for better decisions that improve process quality.
- With the GE solution, Blaser Swisslube has leveraged easier troubleshooting, increased productivity and significantly improved process quality. It has also reduced energy costs by up to 45%.

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Profertil is Benefiting from GE Asset Answers

Profertil, an Argentine petrochemical company producing nitrogen fertilizers, identified its 02-F-201 primary ammonia reformer as its top bad actor out of all assets between 2008 to 2010. Over that time period, the company roughly spent $3.2MM maintaining this specific asset. In 2010, Profertil undertook a significant project to address an issue of chronic tube failures on that specific reformer. With an initial investment of $8MM, the company was challenged with understanding how well the asset was performing, how much it could improve, and how much return on investment (ROI) would be realized from the project implementation. The company didn't have a tool to track exactly how much money had been saved or how much the reliability of an asset had improved.

Solution

- At the outset of the improvement project, a maintenance cost of $70,000 per year was predicted and no production losses were estimated or forecast. Profertil set out to monitor and track the success of this project using key performance indicators (KPIs).
- In 2013, Profertil selected Asset Answers, a benchmarking capability found within GE Digital's Machine & Equipment Health solution, part of the Asset Performance Management (APM) suite. Asset Answers provides instant benchmarking of the company's physical asset performance against that of global industry peers, and also internally, asset to asset and site to site. The tools and KPIs available empower users to clean, filter, and interpret performance data to systematically diagnose and isolate underperforming assets.
- Profertil wanted to measure the success of asset reliability improvements, setting the measurement date to start for March 2008, when reoccurring tube failures began. Using existing and historical data, Asset Answers automatically calculated the average monthly maintenance cost as $27,000 and the average monthly production loss as $1.8MM, by looking at the work order data falling in the 2-year period.
- The solution also automatically calculated the predicted payback time of the improvement project as less than a year, based on present costs, estimated future costs, and the opportunity and investment.

Results

- With Asset Answers, Profertil was able to analyze data in a matter of minutes, simply view KPI trends to understand improvements, justify its investment into an APM solution, and ultimately save money.
- The company saw the following results:
- Saved approximately $0.9MM
- Reduced monthly average work history maintenance costs from $27,000 to $5,000
- Consistently and predictably saved money every month by tracking costs and lost production

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Honeywell Automation College - Distillation

Training courses provide both the supplier and the students with IIoW relative to processes. Distillation is an important chemical industry process. Mcilvaine has done extensive analysis of aspects such as mechanical vapor recompression. This is a lower level course but is illustrative of the potential for higher level courses as well

- Operator Training & Simulation: Fundamentals – Distillation Operation
- This course provides participants the ability to develop competencies for the role of console operator involved in distillation operations: • Develop fundamental operating knowledge and skills • Develop knowledge of unit operations and management • Operate process plant under normal conditions • Anticipate and respond to abnormal conditions
- The course is offered for self-paced exploration and learning using a generic distillation process simulation model typical within the industry. The student follows a structured lesson plan while interacting with a virtual process plant training simulator using an emulated console, schematics and faceplates. The course begins with an orientation presentation which provides an introduction to the process model along with an overview of the course objectives, tools and how to ask for help. This followed by four self-paced lessons
- Each lesson starts with statement of the lesson objective. The student then progresses through a learning session, application session and review session in sequence. The application session involves a practical exercise using a simulation of the plant and operator console. This type of interactive learning has been shown to be the most effective for knowledge transfer. The evaluation session provides the student with timely relevant feedback in the form of a quiz. Immediate feedback is another key success factor for effective knowledge transfer

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IBM allows Chemical Companies to Leverage the Cloud

Leading chemicals and petroleum companies leverage the cloud for:

• Operational innovation --Simpler and faster processes drive internal efficiency; reduced complexity enables better governance and expanded access to more and broader data to manage risk; and IT capacity is better aligned to business volumes.

• Revenue model innovation – Customer relationships, data and other assets are monetized more readily; time-to-market is enhanced; and relevant partner services are incorporated more easily.

• Business model innovation – Third-party services extend into the chemicals and petroleum ecosystem; open collaboration and sharing are expanded; new types of business can be pursued; and innovation is introduced systematically

IBM has a unique position in the

• Business and technology strategy consulting services that help clients leverage cloud to develop executable strategies and transform their businesses, operations and organizations by delivering business value through technology.

• The next generation, enterprise cloud service delivery platform, IBM Cloud solutions offer clients unprecedented service level control. This common IBM architecture for private, public and hybrid clouds is based on IBM hardware, software, services and best practices.

• A robust set of IBM Cloud services: computing, storage, backup, SAP, security and unified communications. • Consulting, design, implementation and infrastructure component management services that create an IT environment dynamic enough to effectively support cloud computing deployment.

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IBM Recommendations for Cloud Success

To succeed with cloud, chemicals and petroleum companies have to assess its impact on the operating model and determine what actions are required for more effective cloud adoption.

• Source and manage partnerships and alliances efficiently. Automate procurement and sourcing functions. Define service-level agreements to secure customer data in a shared environment.

• Proactively redesign business architecture and processes. Integrate legacy processes into new cloud-enabled, dynamic processes. Establish available and reliable cloud-based platforms.

• Change organizational design and governance. Prepare to mitigate data privacy and compliance risks with strong risk management systems.

• Evaluate existing performance management. Develop strategy and metrics that address new levels of reporting complexity. Build performance metrics into contracts for cloud-based services.

• Develop critical new cloud capabilities. Foster skills in customer and service orientation; vendor and relationship management; and virtualization and network technologies. Build deeper data analytic and operational capabilities.

• Increase adoption of emerging technologies. Update IT strategy to support new business strategy and cloud enablement. Adjust budgets to cover costs of legacy systems and new network bandwidth.

• Reassess location strategies for optimal cloud adoption and to enhance the customer experience. Decommission or consolidate technology assets.

• Promote organizational culture changes. Educate employees about organizational changes.

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Linde Provides Complete Hydrogen Solutions for Chemical Plants

- Combining the know-how of the Engineering Division – and the Gases Division – Linde is in the unique position to build, own and operate complete hydrogen plants for continuous supply of hydrogen over the fence to large refineries and chemical companies. The extensive feedback of operating data and information on process and equipment performance in operating plants provides Linde with substantial background for the yet more efficient design of future plants. More than 200 new hydrogen plants have been built all over the world, for clients in the refining, chemical and fertilizer industry, with capacities ranging from below 1,000 Nm3/h to well above 100,000 Nm3 /h, and for processing of all types of feedstock. Most of these plants have been built on a lump-sum turn-key basis.
- Linde is the only company who owns all technologies inhouse, covering the complete range of petrochemical feedstocks from natural gas through LPG, refinery off-gases and naphtha up to heavy fuel oil, asphalt and coal. These technologies are basically: – Steam reforming technology for light HC-feedstock combined with Linde´s own PSA systems for hydrogen purification. – Partial oxidation technology for heavy HCfeedstock followed by a sequence of various integrated process steps to shift, desulfurize and purify the raw hydrogen. The pure oxygen for the gasification is produced with a Linde air separation unit.

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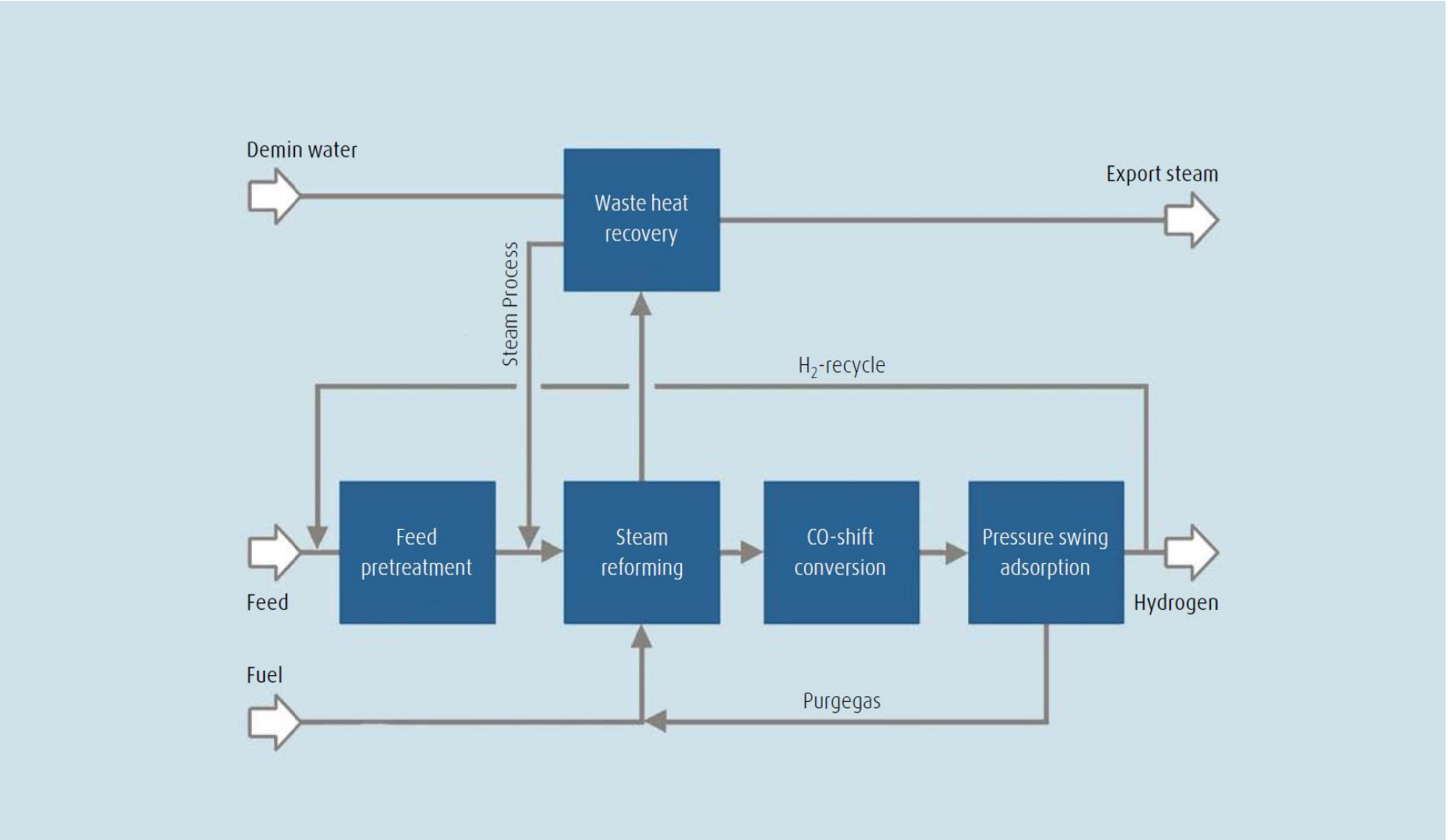
Linde Hydrogen Process



The basic process steps 1. Hydrodesulfurization of feed stock 2. Steam reforming 3. Heat recovery from reformed and from combustion flue gas to produce process and export steam 4. Single stage adiabatic high temperature CO-shift conversion 5. Final hydrogen purification by pressure swing adsorption

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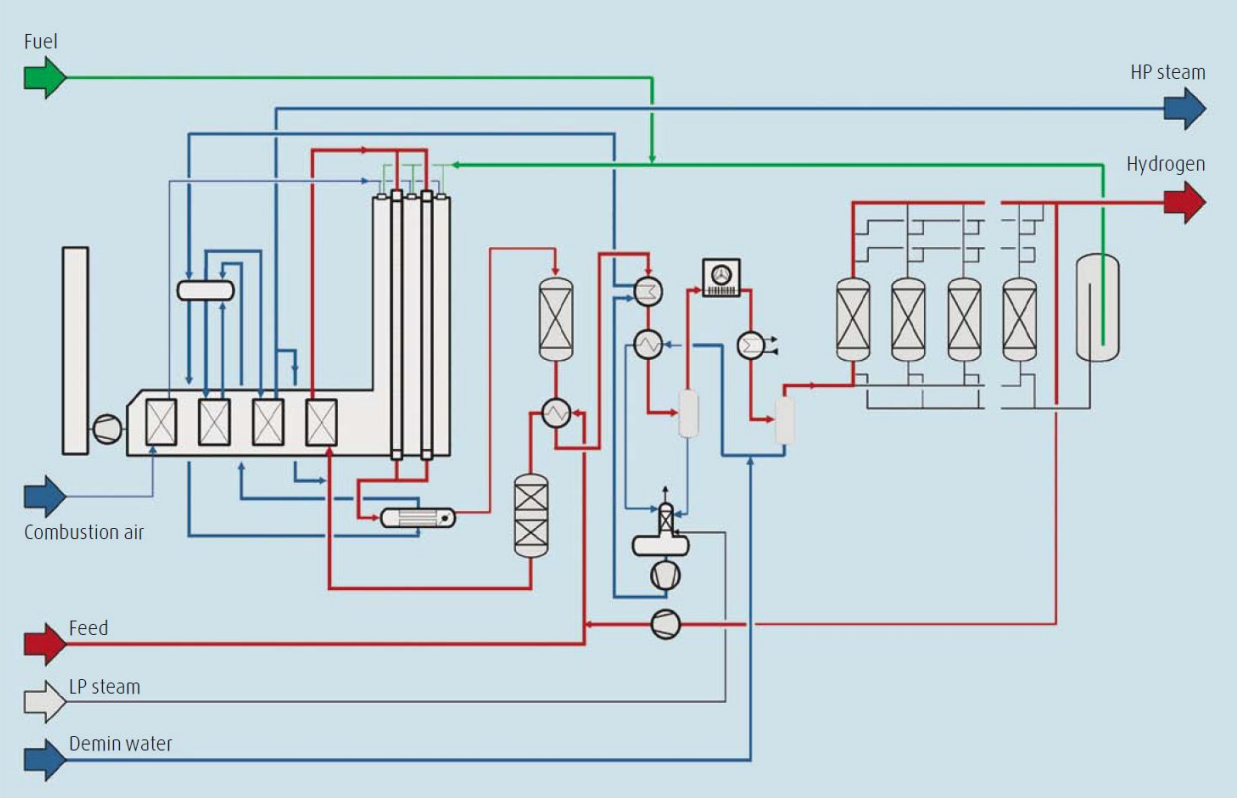
Linde Hydrogen Systems Utilize Lots of Flow and Treat Components



The systems involve a variety of gases and liquids with use of multiple pumps, valves and treatment devices.

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Linde Ozone for the Chemical Industry

- Ozone is used in the chemical processing industry to manufacture fatty acids, which are used after estrification as plasticizers in PVC. It also has applications in water, wastewater and air pollution control
- Water treatment: Ozone has twice the oxidation effect of chlorine, providing an effective means of killing viruses and bacteria. Ozone reactions are considerably faster than chlorine reactions.
- Waste water treatment: The phenol content of industrial wastewater containing cyanides and phenols can be reduced to 1ppb after oxidation with ozone. When ozone is used in conventional sewage treatment plants, there is a reduction of the BOD (Biological Oxygen Demand), the COD (Chemical Oxygen Demand), and the amount of organic carbon, along with sterilization of the wastewater. Ozone is also more effective than oxygen as an oxidant in sludge water treatment, where it also improves the conditions for dewatering.
- Oxidation of NOx in air pollution applications. Ozone is injected in to catalytic cracking scrubbers to oxidize NOx to a soluble NO2. Mcilvaine conducted 9 hours of webinars for BHE and it was determined that ozone will be the best solution for a $700 million problem. Tests are now in progress for what would be the first use in a large utility boiler

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McKinsey Model helps Chemical Manufacturer Understand Variations in Value Chain

- Manufacturers with complex operations often struggle to optimize production. Large chemical makers are a prime example. They face complexity in spades—such as volatile costs and prices, the need to manage multiple plants, and the reality that many products can be made from diverse (and often nonlinear) combinations of inputs. Advanced data modeling recently helped one global chemical maker to cut through all these problems in its flagship plant. Company experts in sales, production, and optimization assembled raw-material and product price curves, market-size forecasts, historical equipment-performance data, and more than 600 decision variables into a mathematical model describing the plant's production yields under various operating conditions.
- The resulting model offers managers a precise understanding of the effects that variations anywhere along the value chain can have on the production network as a whole. The company can now, for example, easily fine-tune the mix of raw materials and finished products, as well as the routing of manufacturing flows, in real time—while constantly identifying opportunities for improvement (exhibit). All told, these changes increased the plant's EBIT returns by more than 50 percent, and the company is now applying this model across its full factory network so that production capacity can shift in modular fashion. A major side benefit: better cross-unit collaboration, since business decisions that were formerly siloed and subjective are now made with a clearer sense of the constraints and trade-offs involved.
- Information on this model - Patrick Briest is a specialist in McKinsey's Düsseldorf office, Valerio Dilda is an associate principal in the Paris office, and Ken Somers is a master expert in the Antwerp office.

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Microsoft Dynamics used for ERP Solutions by SAGlobal

- SAGlobal provides Microsoft Dynamics implementation services and industry-specific solutions to customers in over 75 countries worldwide. We're one of the leading global Microsoft partners and everyday we help over 76,000 Dynamics users worldwide to deliver operational excellence and financial performance for their organizations. The SAGlobal solution offers the chemical industry a set of ERP solutions and modules based on Microsoft Dynamics that allows companies to optimize the value creation chain, facilitate safe manufacturing processes and improve logistics and delivery capacity. The solution will support all business processes while maintaining compliance with regulatory and industrial standards and implementing internal quality guidelines. Customers include manufacturers of lubricants, pigments, acrylics, specialty chemicals and coatings.
- With 22,000 customers around the world, Microsoft Dynamics AX is Microsoft's flagship global enterprise resource planning (ERP) software solution. By combining best-in-class ERP functionality, purpose-built industry capabilities, and the simplicity that you've come to expect from a Microsoft solution, this powerful software platform helps quickly drive value across your business by helping you standardize critical business processes, maximize efficiency levels, and put real-time information in the hands of your key stakeholder

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Nalco already providing IIoT and Remote O&M

- Nalco has 24/7 remote monitoring and support
- Nalco has prodigious process knowledge on water and wastewater technology
- The company has integrated monitoring systems into their programs
- A number of examples of Nalco remote O&M have been provided in the previous IIoT webinars
- Nalco has been a wisdom provider as opposed to just treatment chemicals
- Revenues and margins depend on wisdom as much as on the product qualities.
- An example of wisdom is the Nalco purchase of the Mcilvaine mini-scrubber which measures practical particle size for scrubbing purposes and not the misleading conclusions of cascade impactors

Dow Teams with Northwest Analytics to Predict Trends

- Lloyd Colegrove and his team from the Dow Analytical Technology Center stated that the company currently often underuses, misuses, or misinterprets much data. Dr. Colegrove argued that when put in a much wider context, analyzed automatically, presented attractively, and enabled to act on weak signals, data provides "wisdom" that can guide the company. In this manner, the data can help "justify actions to fix, guide actions to improve, and prescribe actions to make breakthrough changes."
- Dow Chemical partnered with Northwest Analytics to use that company's Focus EMI solution to take in data from appropriate data sources, apply analytics to predict trends based on newly discovered relationships, and present results to all levels in the company for strategic, tactical, and real-time purposes. The company went through a culture change.
- Colegrove illustrated this with a case in which guessing and post-mortem analysis after a plant trip was replaced by acting upon an analytics-fueled dashboard to be able to make the right operating decisions in time to prevent equipment degradation.
- He showed how some plants gradually improved performance, moving from dashboards with many red indicators to those with mostly green indicators. The problem wasn't that the information was not available before, it just was not either given the right focus, or resources were lacking to analyze the information. In the next stages of the project, Dow plans to roll out the systems to other business units, continue to build on its knowledge base, expand the use of collaboration, and continue to "develop, partner, and dream."

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Rockwell Supplies Comprehensive Automation for Syngenta Crop Protection

Syngenta Crop Protection's agricultural chemicals plant in Omaha, Nebraska produces fungicides, herbicides and insecticides, as well as protective coatings for seeds. The plant is located on 42 acres with 26 buildings, six active formulation facilities and five tank farms. Syngenta worked with Rockwell Automation system integrator Interstates Control Systems Inc., and implemented primary and secondary domain controllers and servers from Rockwell Automation, including these FactoryTalk® solutions:

- FactoryTalk ProductionCentre® on an SQL server running Java for shop-floor interfaces.
- FactoryTalk Metrics for overall equipment effectiveness (OEE) reporting.
- FactoryTalk AssetCentre for equipment management.
- FactoryTalk Batch.
- FactoryTalk View Site Edition.
- FactoryTalk Historian.
- FactoryTalk VantagePoint® reporting software running on a VantagePoint SQL server.

All of these servers reside on ESXi virtualization servers running VMware software.

- "Our new PLCs are programmed modularly, so recipes can control groups of equipment following the ISA S88 standard," explains Darrell Hanson, systems engineer for Syngenta. "New recipes are set up by formulation engineers instead of PLC programmers. Orders are entered into campaign manager software by QA lab personnel for each batch to be produced, and operators start and control all batch functions using FactoryTalk Batch.
- "All data is recorded using FactoryTalk Historian, and batch reports and KPIs are viewed with FactoryTalk VantagePoint," he says.
- Overall, FactoryTalk software and the PlantPAx® process automation system, along with other supporting solutions, gave the company faster time-to-market and improved asset utilization because they could use the same tanks to make more and different products, and reduced total cost of ownership and enterprise risk management,

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Whitmore Manufacturing Converts an all Manual Lubricant Facility to a Fully Automated Plant with an Information Powered Rockwell System

- Whitmore produces over 16 million pounds/yr of lubricants at its Rockwall Texas plant. Recently it embarked on a $20 million expansion and automation of batch mixers
- The multi-year project began by installing an Allen-Bradley® ControlLogix® programmable logic controller that was seamlessly integrated with Allen-Bradley IntelliCENTER® motor control software for the facility's charging and temperature control systems.
- FactoryTalk® View Site Edition software from Rockwell Automation provides a comprehensive and accurate view into the newly automated lubricant charging and mixing systems via tight integration to the ControlLogix platform and other FactoryTalk applications.
- FactoryTalk® Historian software tracks key variables, such as lubricant temperature, weight, and mixing time for the facility's more than 20 mixers. Operators now can easily see where modified batches originated by reviewing historical and real-time data.
- The historian information is fed into FactoryTalk VantagePoint® EMI software from Rockwell Automation, which provides greater accessibility to in-context data and trend reports. This manufacturing intelligence solution enables operators to analyze multi-batch data more efficiently.
- Whitmore engineers can now chart connections between average cycle times and production rates. The solution's dashboards allow operators to monitor and troubleshoot the system remotely or on a mobile device.
- All 20 mixers have been automated and the plant has reduced product variation significantly and increased production.

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Schneider Electric Wonderware IntelaTrac for Chemical Processors

- Wonderware® IntelaTrac™ enables chemical processors to achieve safe, reliable and profitable operations through the consistent execution of all field tasks. IntelaTrac fosters a culture of accountability and asset stewardship through a standardized approach to mobile workforce management.
- Since 2002, more than 35 chemical companies have deployed IntelaTrac at over 120 sites to improve their operations 24/7/365 days a year. IntelaTrac Mobile Solutions Deliver Better safety and regulatory compliance: • Enforcement of approved operating and safety procedures • Location tracking – helping validate that required checks have been performed • Easy documentation of safety and regulatory related inspections and activities Less downtime and reduced maintenance costs: • Consistent delivery of accepted equipment and process operating procedures • Early detection of equipment degradation based on “best practice” criteria

• Field execution of approved contingency procedures automatically triggered by “as found” conditions – helping eliminate costly equipment damage and lost production Improved knowledge transfer and reduced employee training costs: • Capture of best practices from experienced field workers • Focused advice and additional reference information availability when a problem is detected • The ability to create step-by-step procedures as part of on the job training Improved field worker efficiency: • Elimination of paper-based data collection with industry leading mobile solution • Immediate filtering of manually collected data to minimize data entry errors

• On-board guidance and documentation – minimizes chance of equipment failure • Real-time modification of operator work flow, based on key internal or external business or operating conditions • More efficient collection of product quality, raw material and energy usage data

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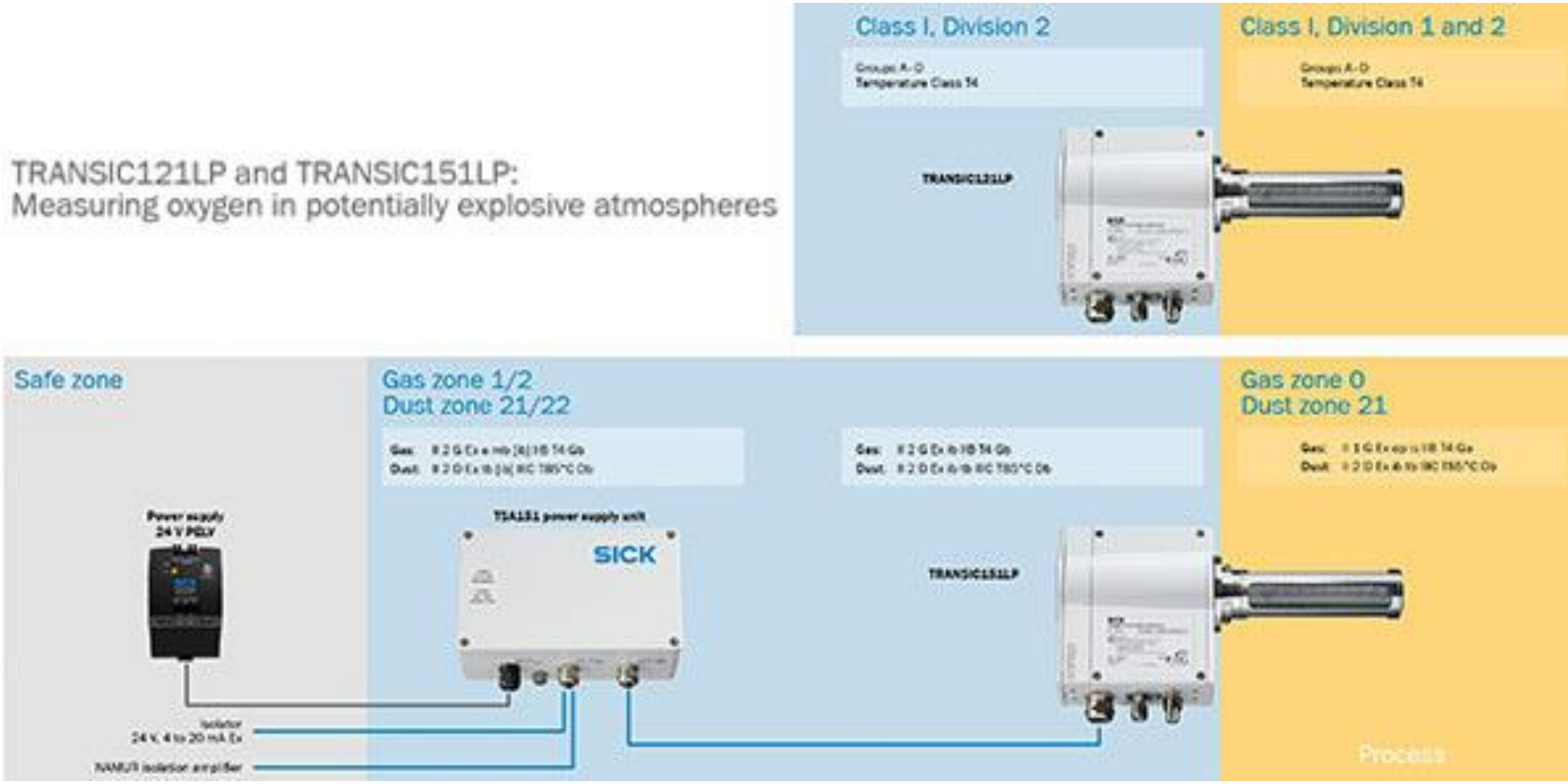
Sick TDL to measure O2 in explosive atmospheres in the chemical industry

The secret behind this reliable O_2 measurement is the TDLS diode-laser spectroscopy.
The TRANSIC100LP incorporates this technology, which is otherwise to be found only in high-end gas analyzers.
For hazardous area applications, there are two approved versions available according to NEC 500 or IECEx/ATEX: gas zone 0 and dust zone 21 for the probe version, and zones 1 / 2 and 21/22 for the measuring device (or Class I
Div. II / Class I Div. I). This means that the TRANSICI100LP is the reliable way to measure oxygen concentration in real time also fail-safe in hazardous areas in the chemical, petrochemical or pharmaceutical industries – and naturally everywhere else where reliability and availability in oxygen measurement make a big difference.



Siemens Comos Provides Tools for Automation at DSM

- DSM's Nutritional Products division is the largest manufacturer of vitamins A and E – and both vitamins are produced exclusively in Sisseln. With the Vitex project, which was completed in 2004, DSM has further consolidated its leading position in the market for vitamin E. The new production facility was equipped with Siemens Simatic PCS 7 as a process control system. It was decided that all partners involved in the planning of the electrical and automation technology for this plant would work with the same tools in Comos.
- Ten years after commissioning, the plant is a mainstay of production at DSM. The processes are continuously optimized, which has allowed the plant yield to be significantly increased in recent years. In addition, the level of automation has increased steadily, reducing the number of manual interventions in the process. These changes are constantly updated in Comos.

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Siemens Tunable Diode Laser Widely Used in Chemical Industry

- TDL (tunable diode laser) technology has found applications in both process gas analytics and continuous emissions monitoring. The major benefit to this in-situ approach to gas analysis is that the measurement is performed non-intrusively and in real-time without any disturbance or delay to gas sampling or gas conditioning,
- In recent years measuring oxygen for safety purposes, measuring ammonia slip and measuring oxygen in thermal oxidizers have been the main applications of the Siemens TDl in the chemical industry.
- The combustion group at Siemens uses a purchased TDL for furnace mapping. A presentation on this technology was provided in 9 hours of webinars which are recorded and available by subscription to
- 4S01 Berkshire Hathaway Energy Supplier and Utility Connect

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Yokogawa, Microsoft, FogHorn, Bayshore Networks and Telit Collaborate on IIoT

- Yokogawa Electric Corporation will work with Microsoft Corporation, FogHorn Systems, Inc., Bayshore Networks, Inc. and Telit IoT Platforms, LLC to integrate their technology into an industrial IoT (IIoT) architecture for the delivery of new services. Through the architecture, business process applications can be configured that will enable plug-and-play sensors, sensing clouds with automatic provisioning, database clouds, historian (data storage) clouds and application development environments to work together.
- Yokogawa's Architecture Development Division California, which was set up in November 2016, will lead the undertaking. Yokogawa's IIoT architecture will integrate the cloud-based Microsoft Azure IoT Suite, FogHorn's fog computing software, Bayshore's security technology for layer 7 of the OSI reference model and Telit's communication modules, sensor onboarding and device management.

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Yokogawa 2nd Generation TDL has Improved Reliability

Yokogawa's new TDLS8000 houses all of the industry's leading features in one robust device. The platform design is for in situ measurements which negate the need for sample extraction and conditioning. The non-contacting sensor allows for a variety of process types including corrosive, abrasive and condensing. The first generation platform has been proven in many others for the measurements of O2, CO, CH4, NH3, H2O and many more NIR absorbing gases. This second generation platform has improved reliability and ease of installation and maintenance while still meeting or exceeding designed application demands.

Mcilvaine conducted a webinar on TDL for NH3 slip and recorded the following presentation
TruePeak - The McIlvaine Company
www.mcilvainecompany.com/.../Donald%20Wyatt,%20Yokogawa%20-%202-14-13....

20 Largest Chemical Companies and IIoT

The 20 Largest Chemical Companies are Identified and IIoT Activities for Dow, Covestro and BASF are described.

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Largest Chemical Companies

Rank	Company	Chemical Sales in 2015	Country
1	BASF	$63.7 billion	Germany
2	Dow Chemical	$48.8 billion	US
3	Sinopec	$43.8 billion	China
4	SABIC	$34.3 billion	Saudi Arabia
5	Formosa Plastics	$29.2 billion	Taiwan
6	Ineos	$28.5 billion	Switzerland
7	ExxonMobil	$28.1 billion	US
8	LyondellBasell Industries	$26.7 billion	Netherlands
9	Mitsubishi Chemical	$24.3 billion	Japan
10	DuPont	$20.7 billion	US

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Chemical Companies - Rankings 11-21

Ranking	Name	Chemical Sales In 2015	Location
11	LG Chem	$18.2 billion	South Korea
12	Air Liquide	$17.3 billion	France
13	Linde	$16.8 billion	Germany
14	AkzoNobel	$16.5 billion	Netherlands
15	Toray Industries	$15.5 billion	Japan
16	Evonik Industries	$15.0 billion	Germany
17	PPG Industries	$14.2 billion	US
18	Braskem	$14.2 billion	Brazil
19	Yara	$13.9 billion	Norway
20	Covestro	$13.4 billion	Germany

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1. BASF (Ludwigshafen, Germany)

- BASF is the biggest chemical producing company in the world with annual sales reaching $78.7 billion in 2014. The German company, headquartered in Ludwigshafen, Germany is focused on industry grade chemicals used in the automotive, construction, and pharmaceutical industries.
- Founded in April 1865, the company was formerly known as Badische und Soda Fabrik, a German word meaning “Baden Aniline and Soda Factory.” BASF was founded by Friedrich Engelhorn in Mannheim.
- In its early days, BASF became renowned for producing dyes. In 1990 the company dropped all its consumer product lines and focused on industrial products only.

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BASF's segments

BASF
We create chemistry

Chemicals

- Petrochemicals
- Monomers
- Intermediates

Performance Products

- Dispersions & Pigments
- Care Chemicals
- Nutrition & Health
- Performance Chemicals

Functional Materials & Solutions

- Catalysts
- Construction Chemicals
- Coatings
- Performance Materials

Agricultural Solutions

- Crop Protection

Oil & Gas

- Oil & Gas

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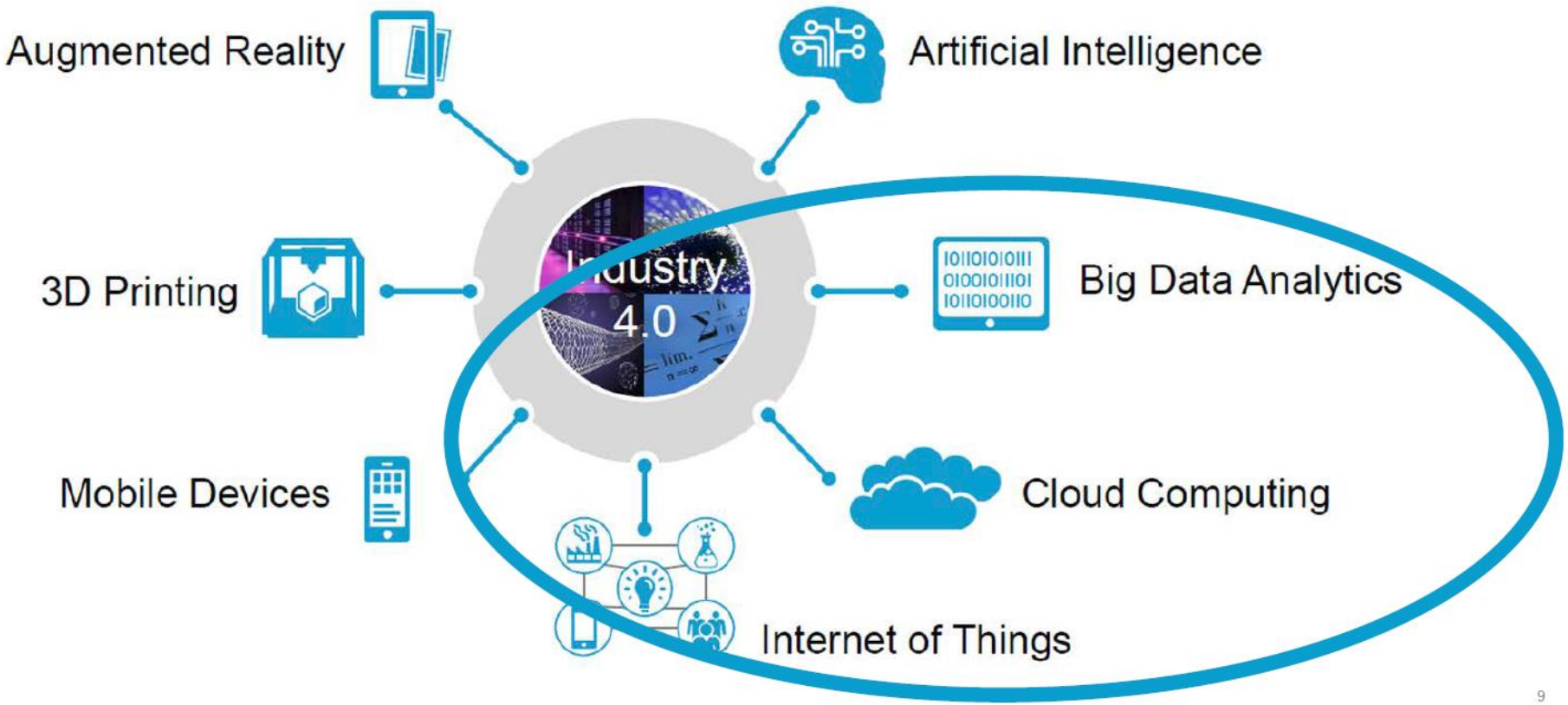
Seven core technologies will enable Industry 4.0 in chemicals

BASF
We create chemistry



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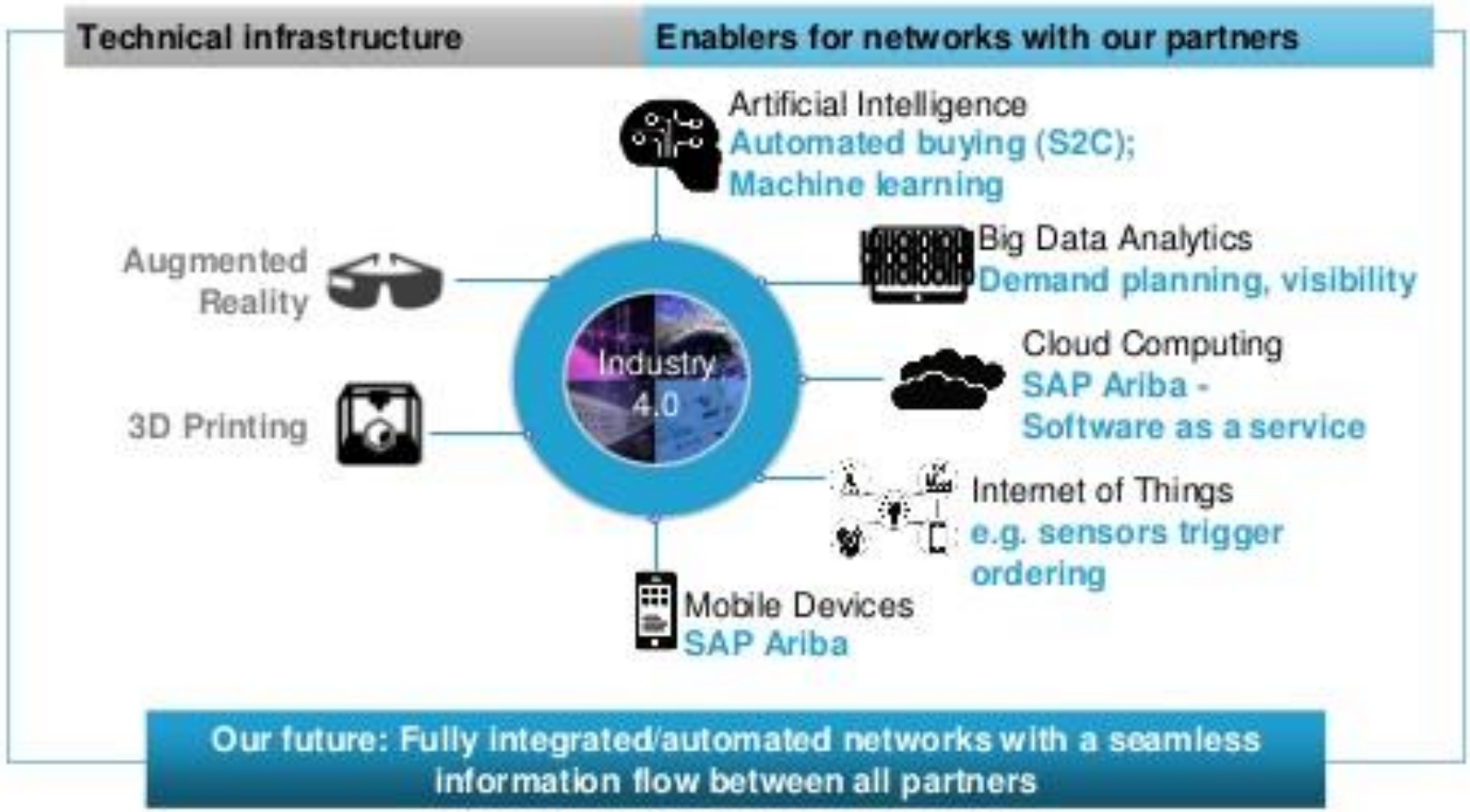
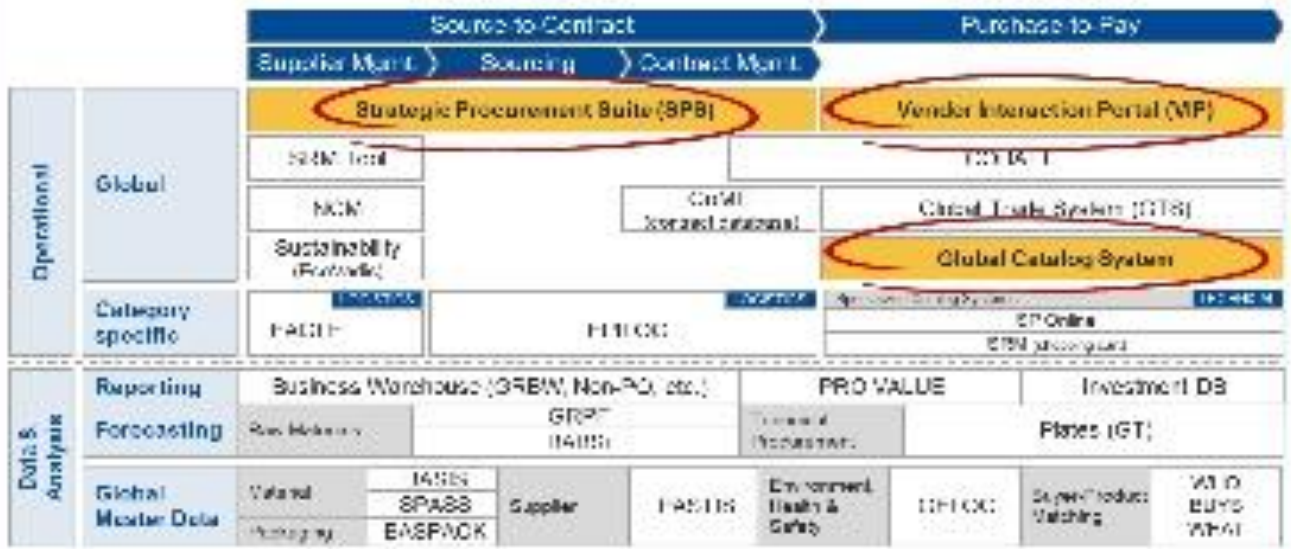
BASF 4.0
Fully integrated networks with our partners



In 2018, the IT landscape will be leaner, globally standardized, and provides one professional interface to suppliers across the globe

2018: GR's IT landscape



Key Improvements

- Through **SAP Ariba**, we want to reach a **new level of connectedness**
- **State-of-the-art business-to-business connection**
- **Standardized software** in the **cloud** facilitates **cost efficiency** and a **marketplace** for the suppliers
- SPS: **One solution for the buyer to manage the supplier**
- **One catalog** enables **efficient search** and **supplier connection**

Key takeaways…

Digital business interaction through Strategic Procurement Suite:

- **Harmonizes across categories (direct/indirect/packaging) the tool landscape**
- **Enables a global network to collaborate for S2C process**
- **Permanent (every 2-3 months) best-in-class new functionalities**
- **Integrated into SAP R/3 backbone**
- **Harmonization, standardization and automation of processes for various internal functions and external suppliers**
  - One UI for all strategic functions in procurement
  - Ensure usage of one globally aligned set of standards
  - Improved accuracy of data
  - Provide set of KPI for strategic topics like supplier management or sourcing

Strategic Procurement Suite for indirect and direct procurement with ERP interfaces

BASF
We create chemistry

Process Scope

Supplier Management (SM)
- Registration
- Qualification
- Segmentation
- Performance Management
- Development & Interaction
- Disqualification / Phase-out

Sourcing (SO)
- RFP/RFQ
- Bid evaluation
- Negotiation
- Auctioning
- Awarding

Contract Lifecycle Mgmt. (CLM)
- Creation & Negotation
- Distribution
- Monitoring
- Administration

Expected benefits

- Increase of Effectiveness
- Increase of Efficiency

Deliverables

- Globally aligned processes & integrated system for strategic procurement
- Global standard tool, rolled out in all regions
- KPIs for Supplier Management and S2C

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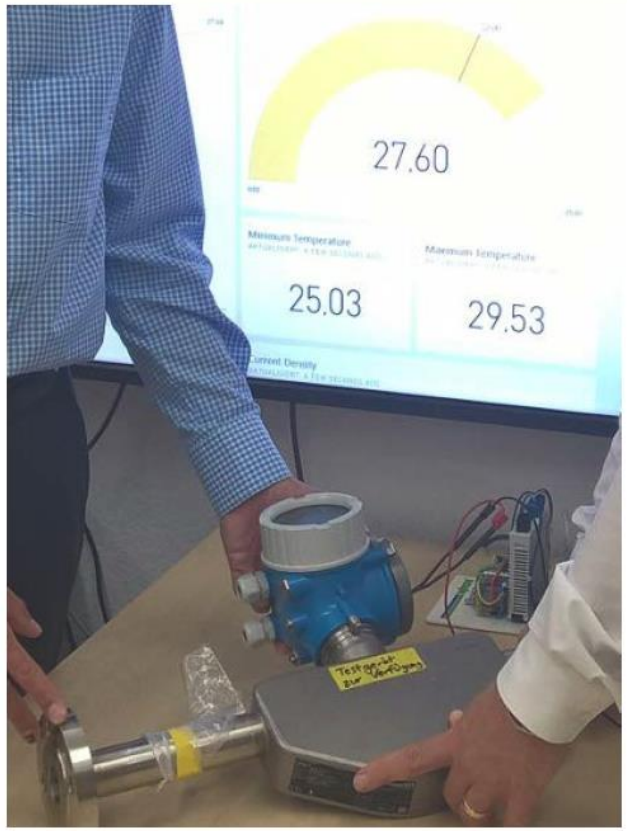
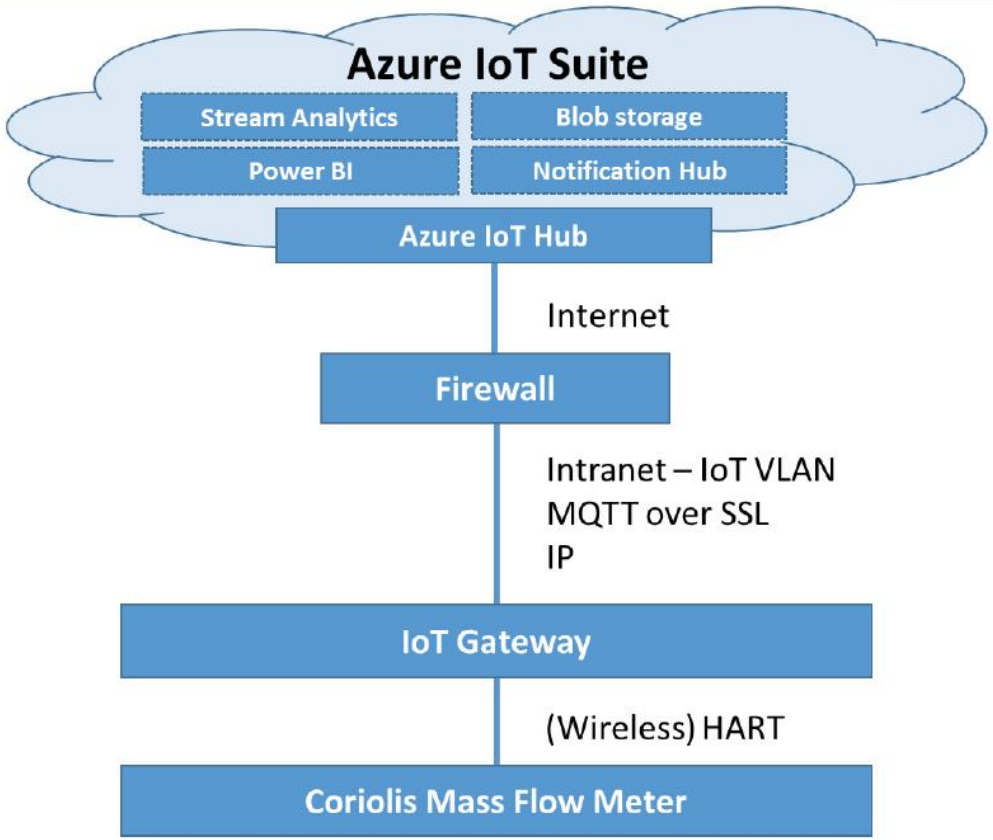
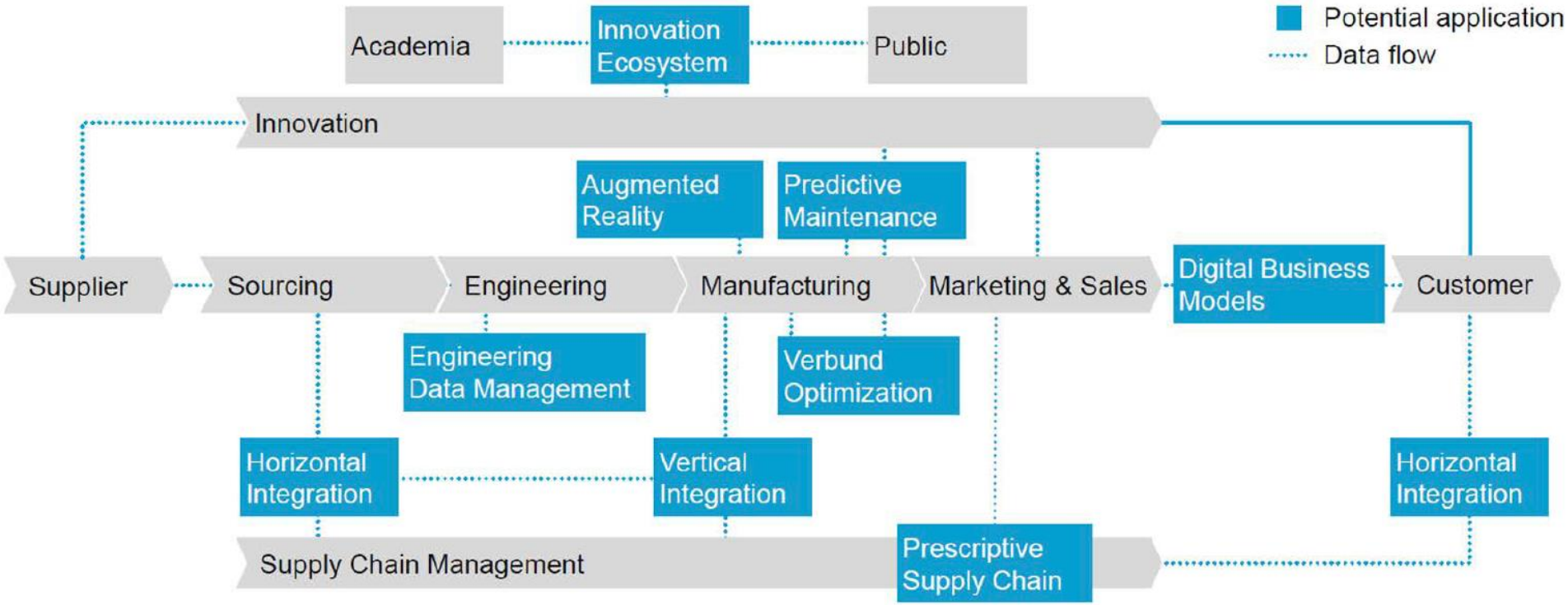
Process Optimization





Attractive applications identified along the value chain



Objectives and Measures to support realization of Business Benefits

BASF
We create chemistry

Organizational

- Setup (virtual) Center of Expertise
  - Closer collaboration of OT and IT
- Identify, pilot and share use cases
- Develop IoT capabilities, skills and resources
- Ensure Cyber Security

Technical

- Create IoT Lab
- Plan, implement and run IoT landscape
  - Cyber Physical Systems
  - Communication
  - Cloud platforms
- Ensure Cyber Security

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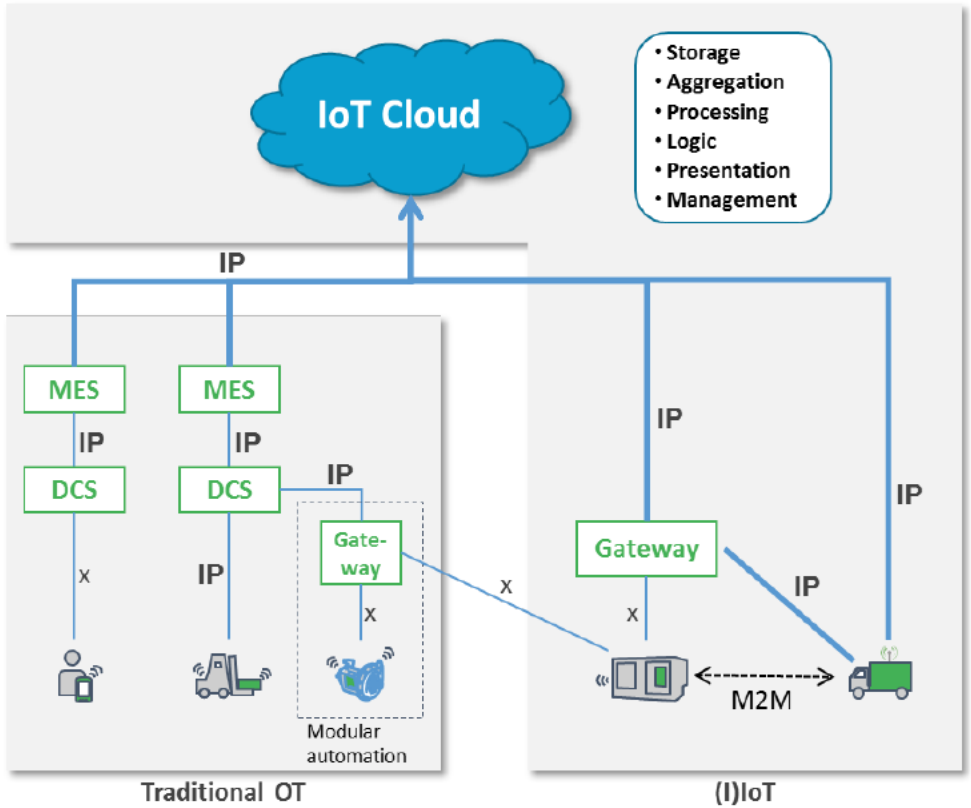
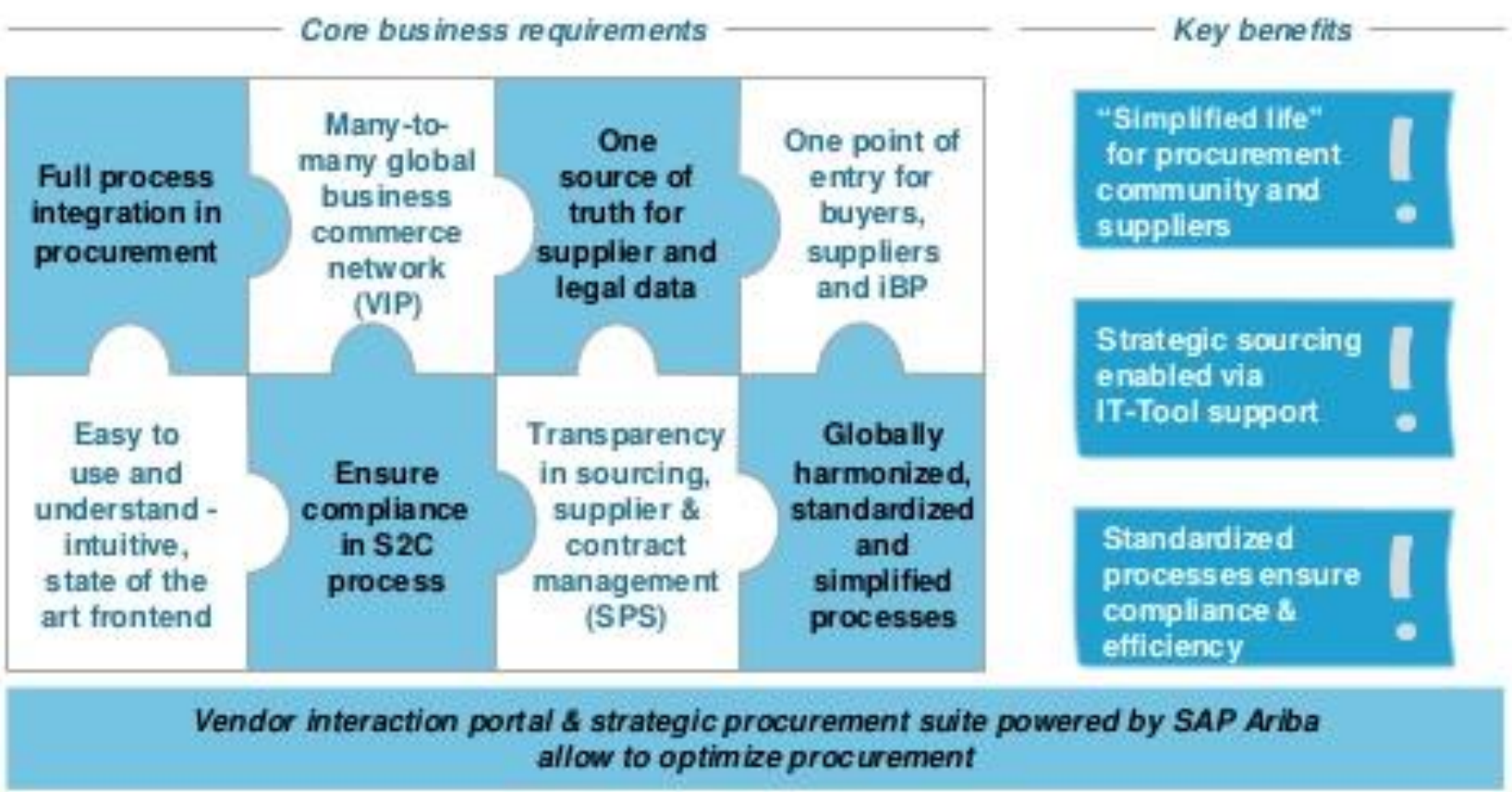
IoT and (traditional) Operational Technology



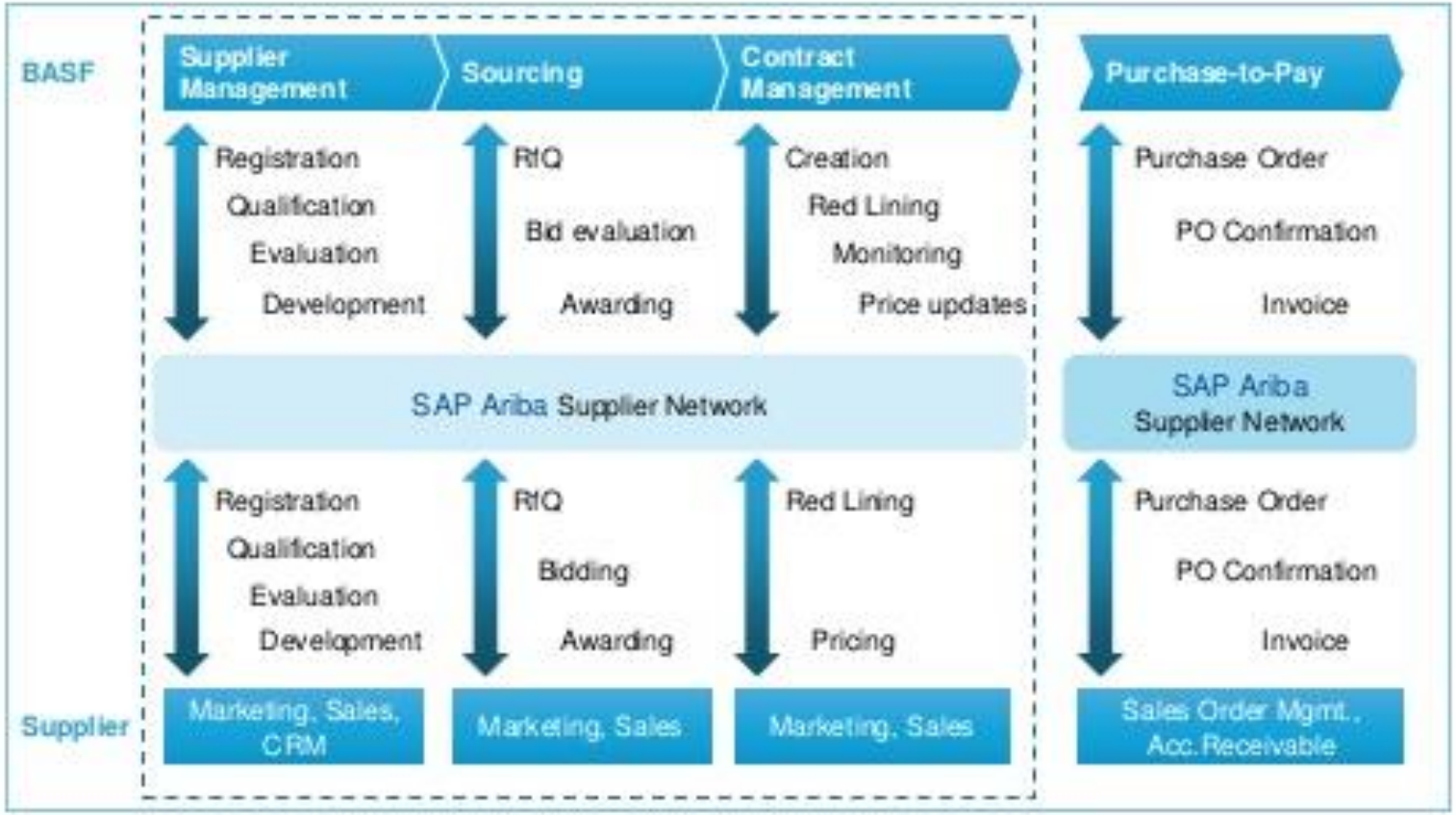
- **Demarcation** of IoT to traditional OT:
  - CPSs connected to IP based network
  - Smartness to exchange data amongst each other or with computer systems
- **Traditional OT** to **control** the plant
- **IoT** to **optimize** production processes and assets
- (I)IoT and traditional OT will **coexist**
  - A thing may be part of both worlds

x: non-IP, e.g. analog or proprietary communication

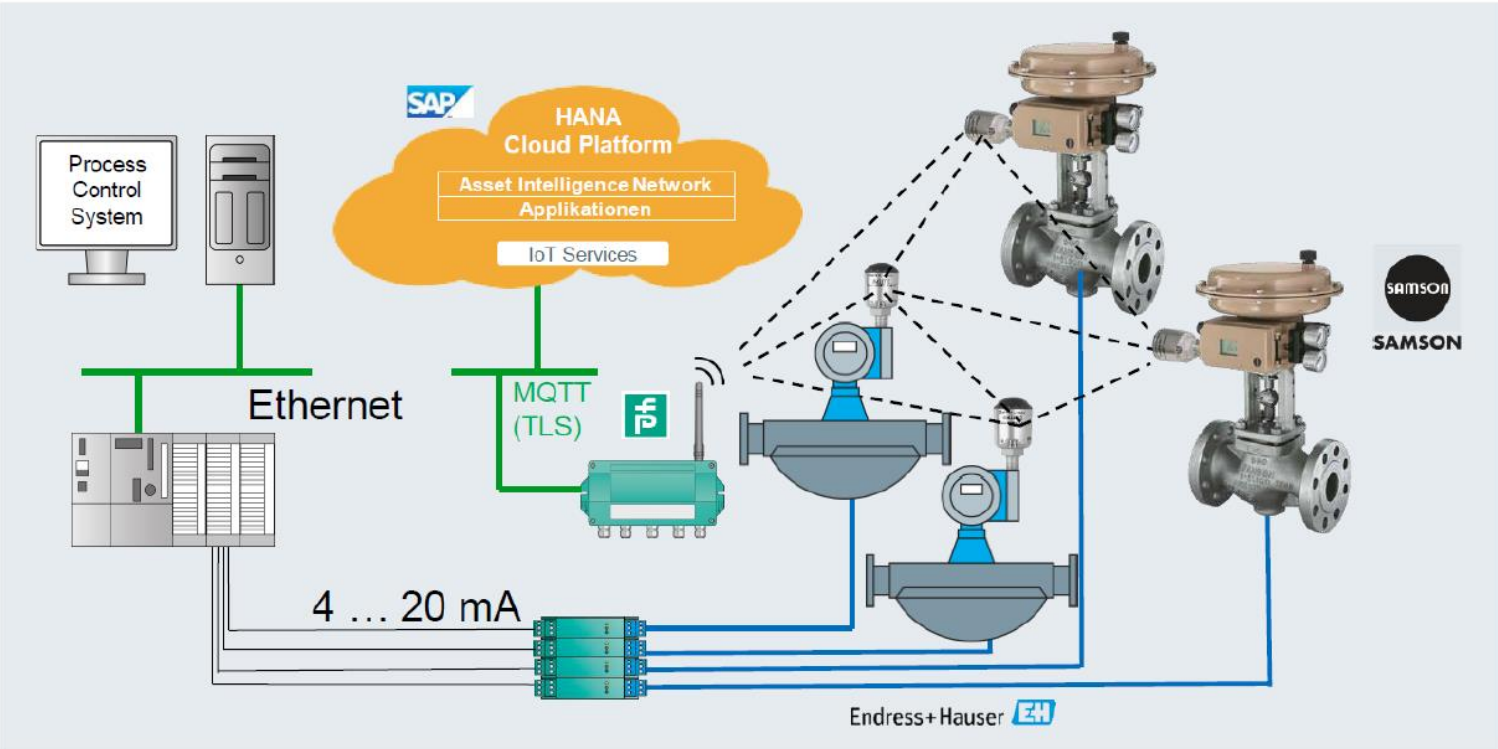
Procurement IT tools
Core business requirements & benefits



How SPS and VIP fit into the digital procurement landscape



Predictive Maintenance - Wireless



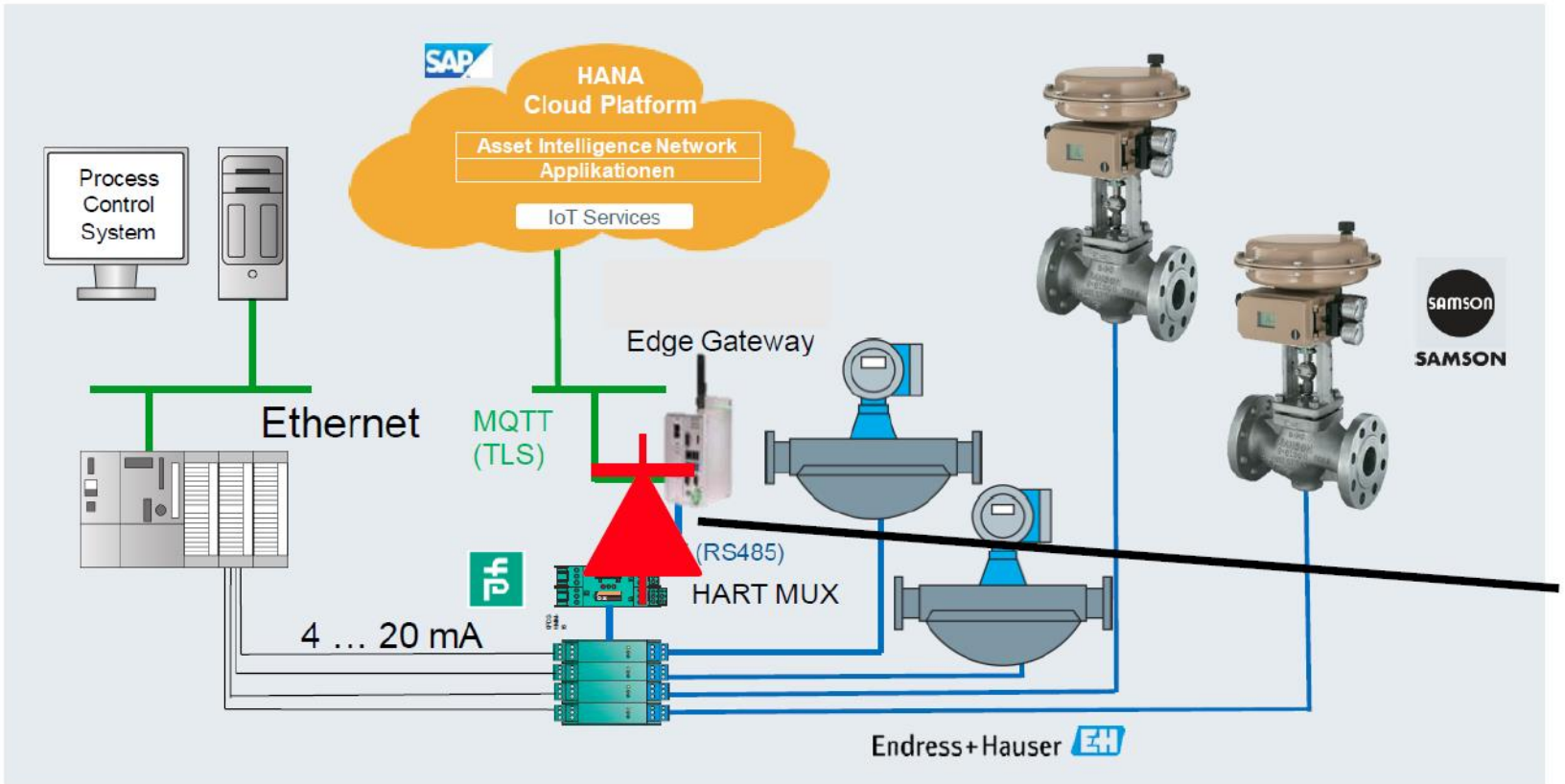
Wireless:

- Second channel
- Independent from plant control
- Easy retrofit
- “Read only” configuration of HART interface

Wireless options:

- Wireless HART
- LoRa
- Sigfox
- NB-IoT
- …

Predictive Maintenance – Wired



Data Diode
to prevent
break-in
from Cloud

Wisdom Created around Gas Analysis is an Example of the Interconnection Potential

Following the acquisitions of SpectraSensors Inc. and Kaiser Optical Systems Inc., Endress+Hauser is deploying new activities in the field of gas analysis. This includes the creation of dedicated Centers of Competence staffed with experts who provide customized solutions for each project according to the application requirements. This willingness to gain process knowledge and provide solutions not just instruments is a good example of the interconnection needed to truly create IIoW. Here are the interconnection routes demonstrated by the amine treatment with TDL described on the next slide.

- Interconnection between supplier and large multi plant operator-E+H is a major supplier to BASF as shown on the previous slide
- Interconnection of experts on specific processes. The tunable diode lasers used to measure gases (H2S) in this case are transforming other gas processing. Mcilvaine webinars on the subject including presentations by Siemens show the big opportunity to measure and control combustion and to measure NH3 slip
- Interconnection among industries: the new wisdom created for petrochemicals, gas processing, coal combustion, and syngas need to be shared. In the case of the chemical industry Sinopec is both one of the largest chemical companies and the largest syn gas producer. TDL technology will be needed for the huge Chinese syngas program.
- Interconnection among suppliers: the wisdom gained by E+H and the power of TDL for continuous process analysis needs to be communicated to suppliers of process systems and suppliers of the cloud based process automation systems.
- Intercommunication of all wisdom contributors. The end users in multiple industries, component suppliers, system suppliers, and process automation suppliers should all be communicating.

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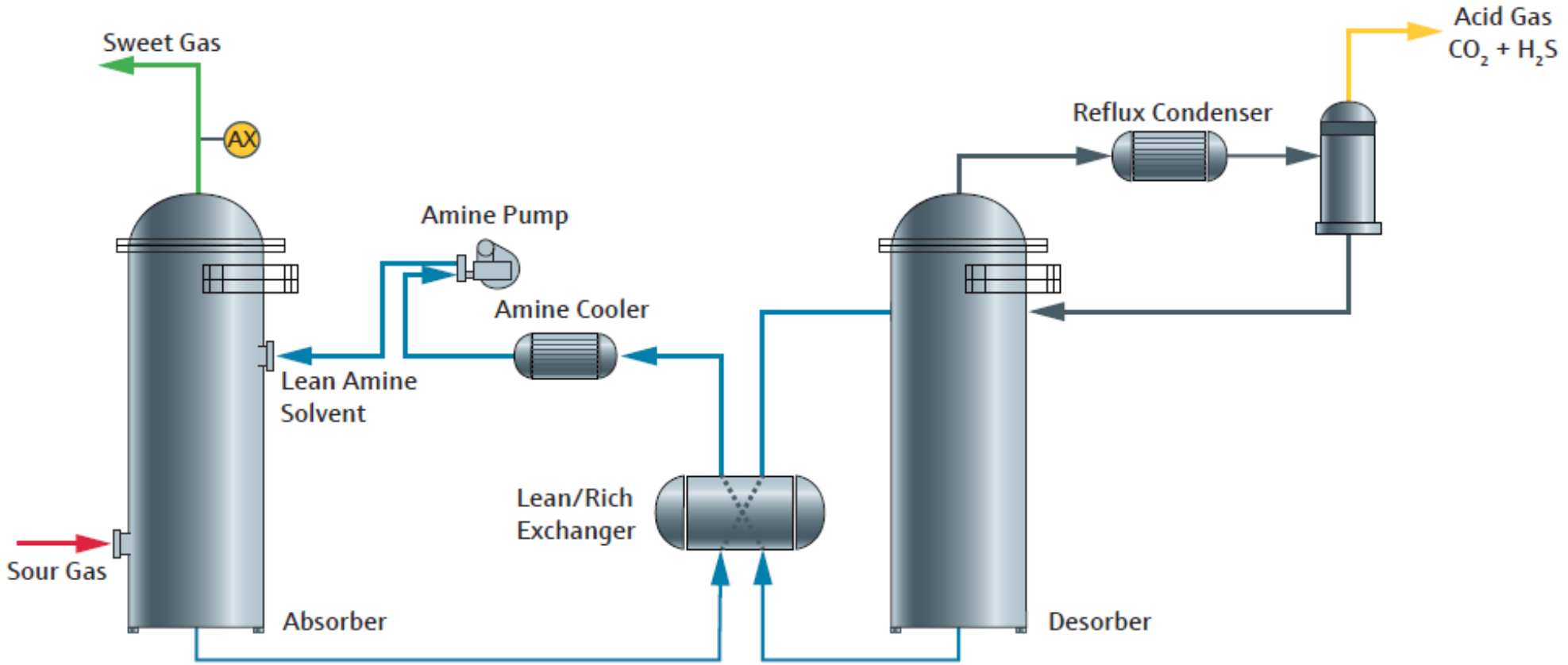
E+H Provides Process Knowledge and TDL

SpectraSensors tunable diode laser absorption spectroscopy (TDLAS) analyzers have proven highly effective for this critical gas processing measurement. TDLAS analyzers have an exceptionally fast response to changes in H2S concentration, an important performance characteristic for monitoring the efficiency of the amine treatment process and quality of the resulting natural gas product.



2. Dow Chemical (Midland, USA)

- When Dow merges with Dupont combined sales will be $70 billion. The Dow Chemical Company is also known as Dow, and it is an American multinational chemical company with headquarters in Midland, Michigan.
- In 2007, the Corporation was the world's second largest chemical manufacturer by revenues after BASF. In 2009 the company was ranked as the world's third largest chemical manufacturer by market capitalization after BASF and DuPont. In 2014 the organization was the second-largest chemical producer in the world.
- The company manufactures agricultural products, chemicals, and plastic products. Dow Chemical has branches in 160 countries worldwide with a workforce of about 54,000 people. The company has seven main operating segments and a variety of products manufactured by each one. In 2012 the company's total sales reached $57 billion, and by 2014 it had reached $58.2 billion.
- The company was founded in 1897 by a Canadian-born chemist Herbert Henry Dow, who was the inventor of a new method of extracting bromide underground in brine at Midland, Michigan. The company initially sold only potassium bromide and bleach achieving 72 tons a day in 1902.

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Dow DuPont to become Largest Chemical Company

When the merger is final Dow /DuPont will be the largest chemical company with sales of close to $70 billion. Dow Chemical and DuPont said their merger's end date was being pushed back but added it was still on track as DuPont moved forward with plans to divest assets, a condition of European Union approval for the deal.

The companies now expect the deal to close in August 2017, after being delayed by intense regulatory scrutiny. When the deal was first announced in Dec. 2015, it was expected to close in the first half of 2016.

Earlier this week, the European Union's competition watchdog cleared the merger on the condition they sell parts of DuPont's global pesticides business and associated research and development, as well as Dow's acid copolymers and ionomers business. Divestitures are commonly required in large deals to assuage concerns over market power and consolidation within specific markets and industries.

Following the EU decision, DuPont said Friday that it would sell its pesticide assets to FMC Corporation for that company's health and nutrition business and cash. FMC will buy DuPont's chewing pest insecticide portfolio, its global cereal broadleaf herbicides and a substantial portion of its global crop protection research-and-development efforts. DuPont is getting FMC's health-and-nutrition business and will also receive $1.2 billion in cash.

In 2017, FMC expects the units it is buying to generate about $1.5 billion in revenue. The health-and-nutrition business had 2016 revenue of $743.5 million.

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EMI at Dow

- At the 2016 Manufacturing Leadership Forum Jim Peters from the Dow Analytical Tech Center presented on Dow's efforts to derive greater value from available process data. Most of the manufacturing process data collected are generally underutilized, and sometimes simply ignored, in the archives of various process historians, LIMS or other databases.
- Enterprise Manufacturing Intelligence (EMI) helps organizations unlock the potential and value of process data by applying analytics in real time and making the results immediately available in context to all levels of the organization for immediate understanding and action. Mr. Peters highlights how Dow is utilizing EMI to better connect analyzed data with the operations to impact production in real-time. Alerts must be meaningful. In a manner similar to alarm management, alerts should be targeted to an audience that is expected to act on them. He recommends EMI dashboards be created for specific roles. Someone in Operations will need to focus on different areas than Maintenance or Engineering.
- Peters emphasized the importance of framing the problem first.

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3. Sinopec (China Petroleum and Chemical Corp)
Ranking for Flow and Treat is # 1

- Sinopec has total revenues of $294 billion. However less than $50 billion is generated in the chemical industry The most downstream of China's big three energy companies (alongside CNPC and CNOOC) Sinopec is more a producer of petrochemicals, fuels, and lubricants than an exploration and production company. It is the world's largest purchaser of flow and treat equipment services
- In March 2017 Sinopec paid almost $1 billion for a 75 percent stake in Chevron Corp's South African assets and its subsidiary in Botswana to secure its first major refinery in Africa.
- Sinopec is Asia's largest oil refiner. The new assets include a 100,000 barrel-per-day oil refinery in Cape Town, a lubricants plant in Durban as well as 820 petrol stations and other oil storage facilities.
- Sinopec Group's key business activities include: industrial investment and investment management; the exploration, production, storage and transportation (including pipeline transportation), marketing and comprehensive utilization of oil and natural gas; the production, marketing, storage and transportation of coal; oil refining; the storage, transportation ,wholesale and retail of oil products; the production, marketing, storage, transportation of petrochemicals, natural gas chemicals, coal chemicals and other chemical products; the exploration, design, consulting, construction and installation of petroleum and petrochemical engineering projects; the overhaul and maintenance of petroleum and petrochemical equipment; the research and development, manufacturing and marketing of electrical and mechanical equipment; the production and marketing of electricity, steam, water and industrial gas; the research, development, application and consulting services of technology, e-business, information and alternative energy products; the import and export of self-support and agent commodity and technology; foreign project contracting, invite bidding, labor export; the international storage and logistics business.

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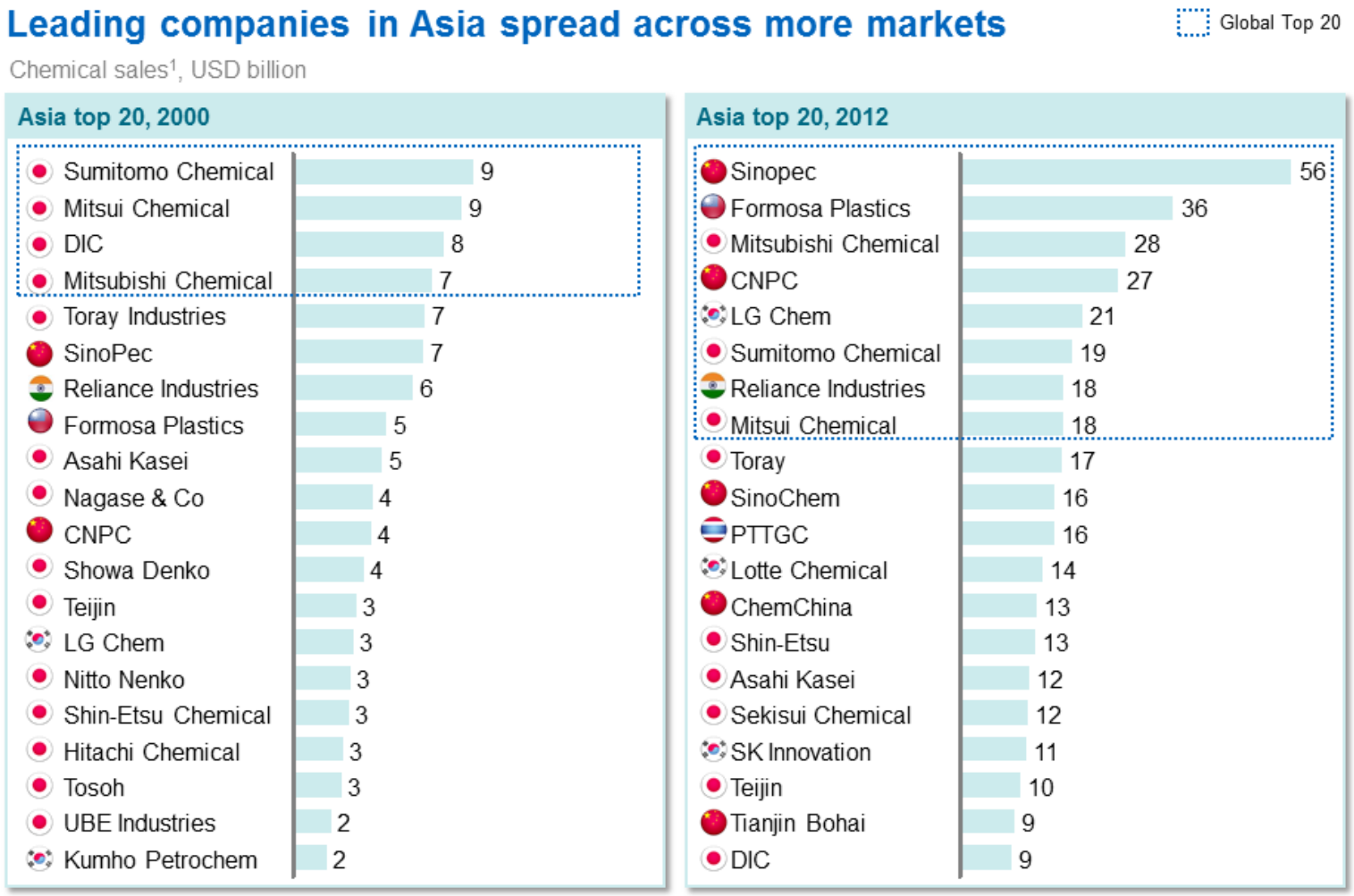
Sinopec has Risen to the Top Position in Asia



1 Total revenue excludes non-chemical sales e.g, pharma, petroleum

SOURCE: ICIS; company reports; C&EN; Chemical Week; Bloomberg; McKinsey analysis

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4. SABIC (Riyadh, Saudi Arabia)

- SABIC is a chemical producing company in Saudi Arabia and is the largest company in the Middle East.
- The company is currently the largest producer of polycarbonate and granular urea and is the second largest producer of ethylene glycol in the world.
- With a labor force of more than 40,000 people, the company has seen its revenue grow to reach $50.4 billion in 2014.
- SABIC (also known as the Saudi Arabia Basic Industries Corporation) was founded by the Saudi royal family in 1976 as an oil refinery. The creation of the company spurred the growth of the neighboring area transforming Yanbu from a fishing village to what is now one of the biggest industrial cities in the world.

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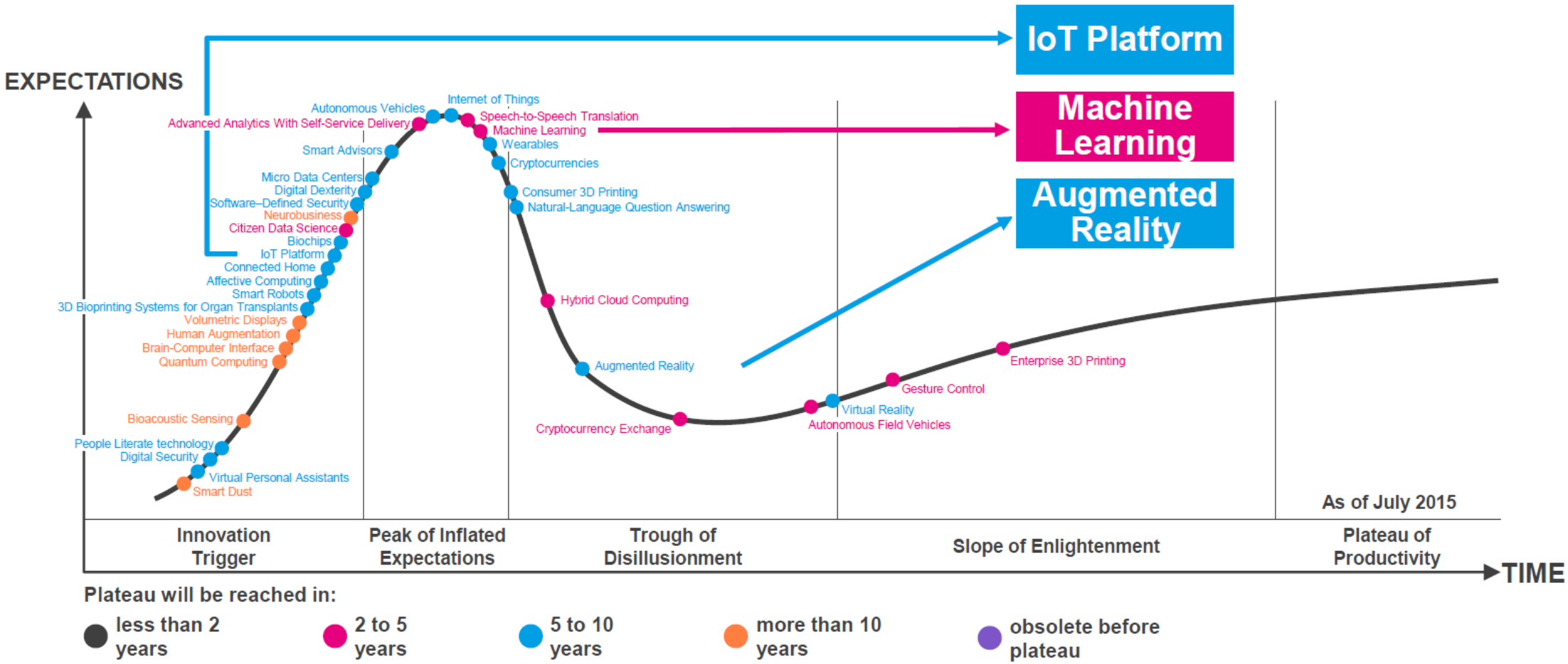
20. Covestro

- The Chemical industry already has many Industrie 4.0 technologies in place. For example chemical companies already employ vendor managed inventory, analytics based on first principles, empirical, and hybrid models. However, new data-driven analytics are emerging. These have been chronicled by Felix Hanisch, Head of Global Process Control at Covestro.
- Data generated by chemical plants have all characteristics of Big Data.. Some cloud applications are therefore mainstream, but most operations management applications and process control are on-premise. And the industry wants to keep it that way.
- A key for the industry is to know where to focus and to recognize if expectations for these technologies are "a pie in the sky" or realistic, according to Dr. Hanisch. To decide where to focus Covestro believes their digital strategy must be organized along the company's vertical and horizontal integration axes. Significant opportunities arise when scrutinizing the processes and applications along these axes. including reduced downtime and improved reliability.
- Chemical manufacturing differs in many aspects from discrete manufacturing, Chemical processes are highly complex and intermingled. Also the toxicity of intermediates and end products adds a multitude of constraints. The industry is also very asset intensive. Clients are more demanding in terms of traceability, ecological footprint or the added value of the end product. This last aspect also represents an opportunity.
- The strategic answer to these challenges is that "Chemicals 4.0" players can thrive when they simultaneously master the supply chain of feedstock and resources, manufacturing efficiency (including intensification and digitalization), as well as customer-specific application value. Covestro has three approaches to digitalization, with different time horizons. In the shorter term, the company aims to "optimize supply," innovating its day-to-day business by improving reliability and supply chain performance. In the midterm, Covestro wishes to leverage growth and innovate how customers do business with the company. This would involve using information and channels to improve customer experience. Longer term, Covestro considers completely new, digitally enabled business models.

Hype Cycle for Emerging Technologies 2015

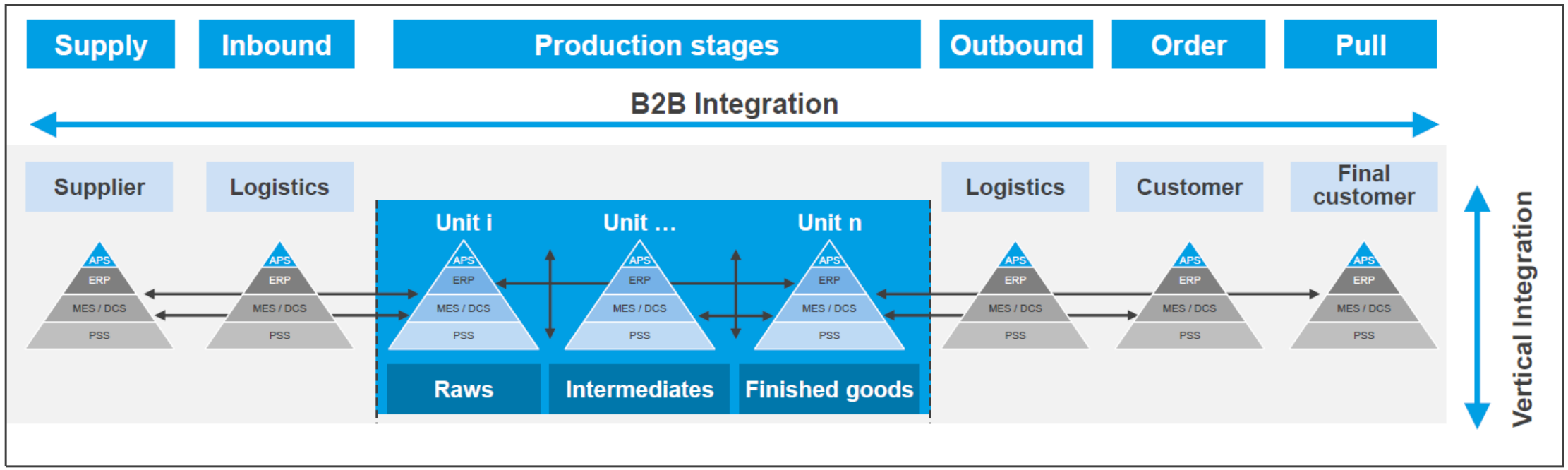
Hype Cycle for Emerging Technologies, 2015



Source: Gartner (August 2015)

Digital strategies require integration from suppliers to customers

Identify biggest value potential in own operations and@interfaces up-/down stream



Integration of own production sites and external partners

Industry 4.0

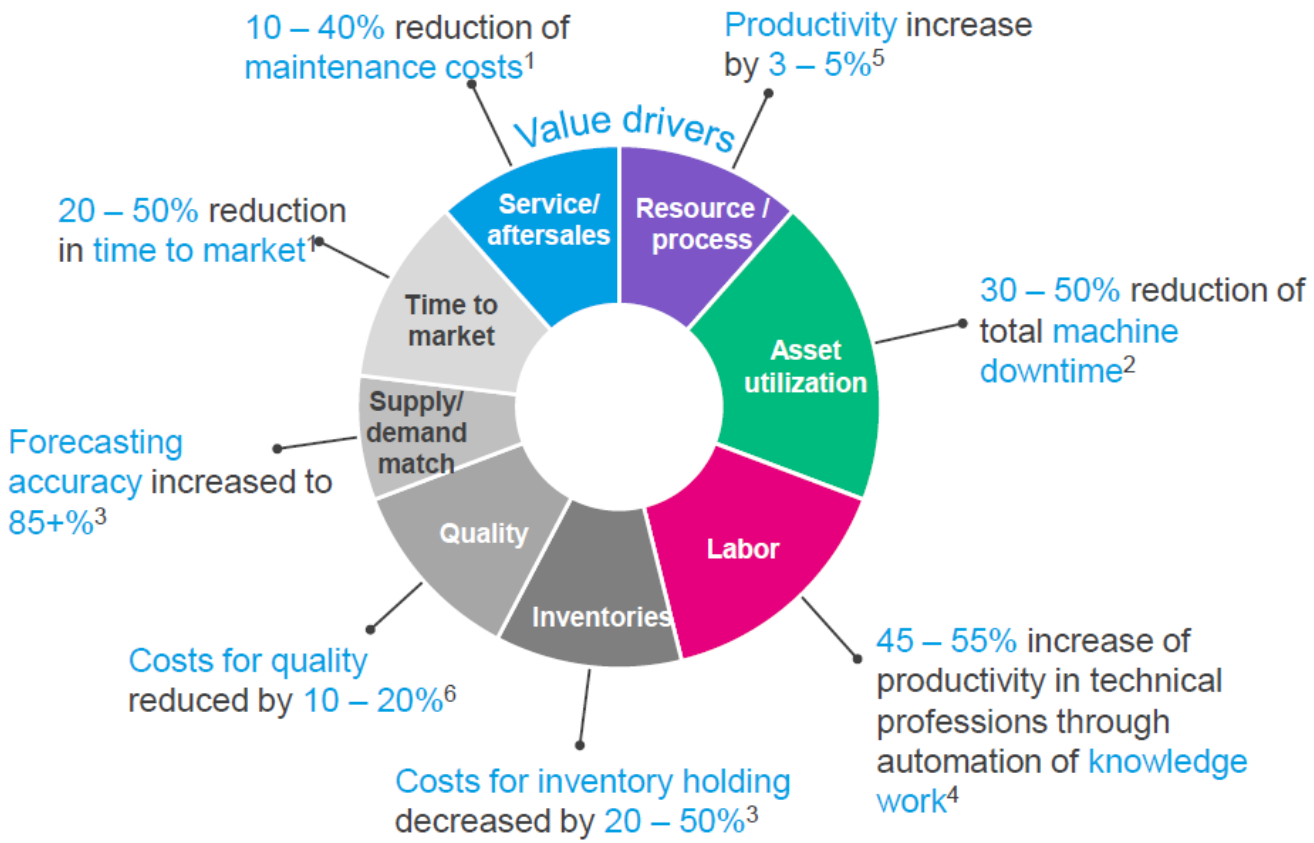
How to navigate digitization of the manufacturing sector

Source: Industry 4.0 How to navigate digitization of the manufacturing sector. McKinsey Digital 2015

Industry 4.0

How to navigate digitization of the manufacturing sector

Indicative quantification of value drivers

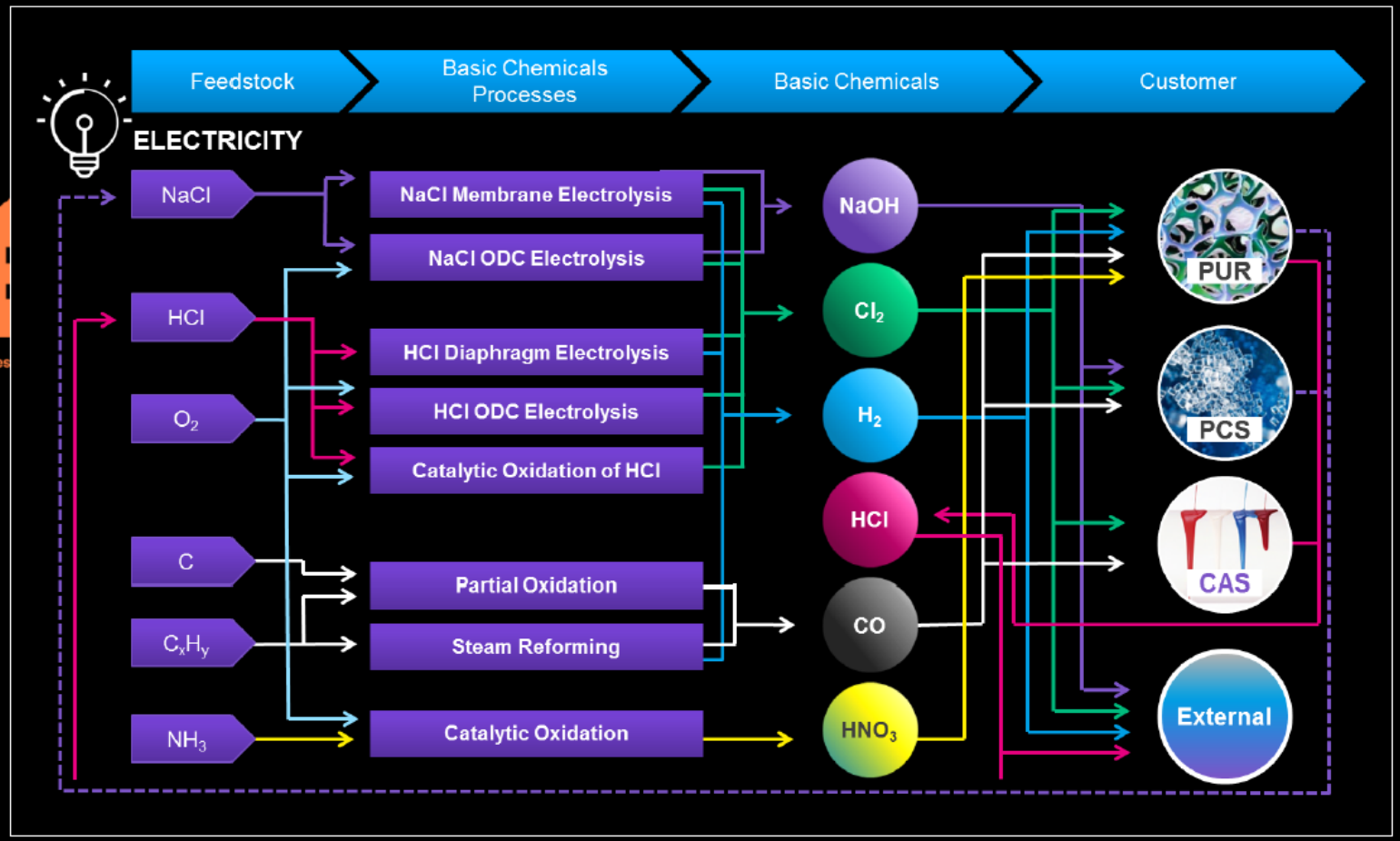


1. Cf. McKinsey Global Institute: Big data: The next frontier for innovation, competition, and productivity
2. McKinsey analysis
3. McKinsey analysis
4. Cf. McKinsey Global Institute: Disruptive Technologies
5. See, for example, ABB case study
6. Cf. T. Bauernhansl, M. ten Hompel, B. Vogel-Heuser (Hrsg.): Industrie 4.0 in Produktion/Automatisierung/Logistik (2014)

Source: Industry 4.0 How to navigate digitization of the manufacturing sector. McKinsey Digital 2015

What is Chemicals 4.0?

Are we different?



Condition Monitoring

Automate routine checks for common equipment using asset model + alerts

redundant sensor diagnostics

plant data

preprocessing
(filtering, standard deviation)

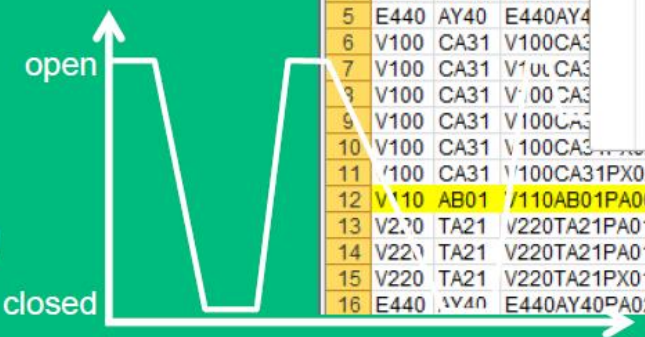
sensor malfunction detection
- fouling
- freezing
- drift/offset

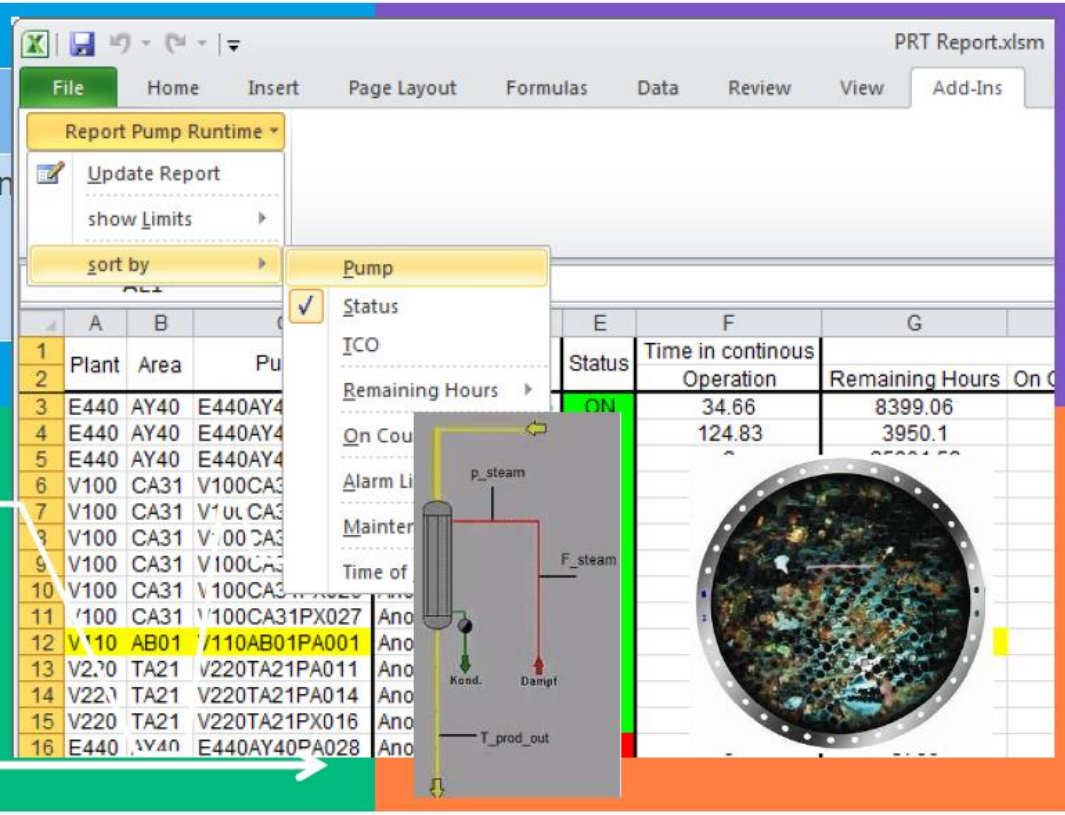
tuning parameters

sensor warning

on/off valves

- cycle count
- monitor opening & closing times
- monitor correct performance of partial stroke tests





pump runtime monitoring

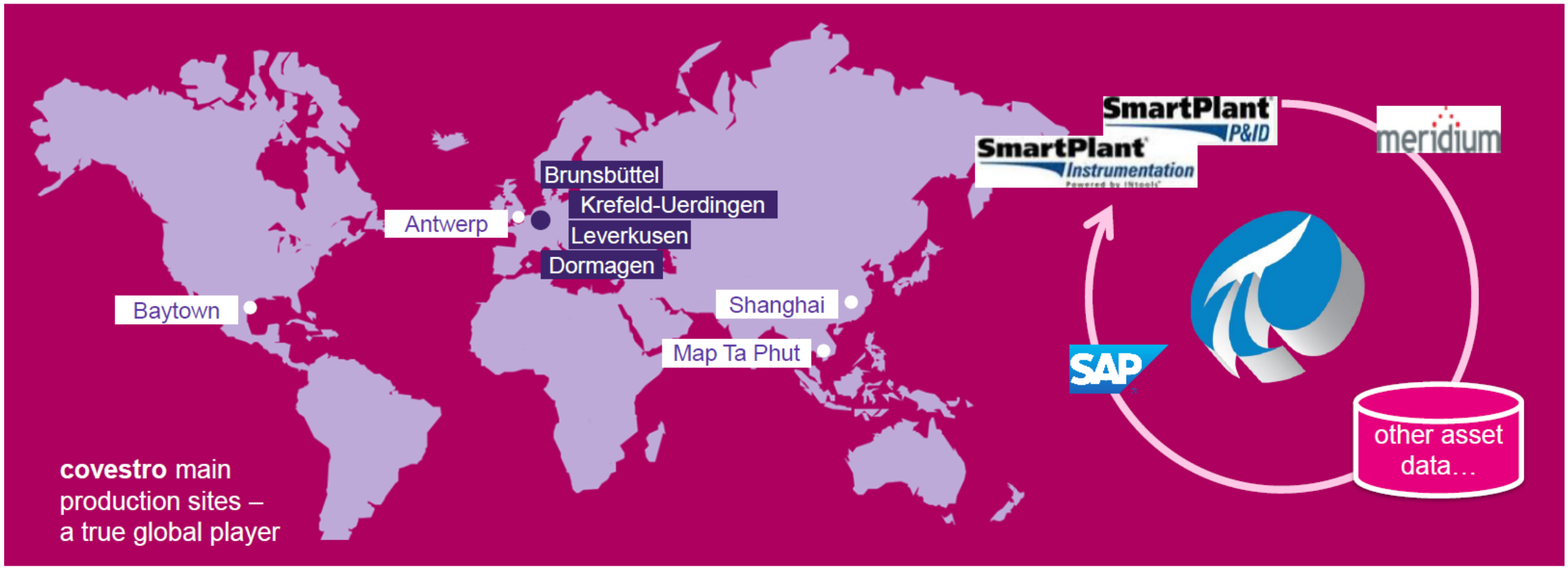
- switch redundant pumps based on runtime
- runtime based maintenance
- identify frequent on/off operations

heat exchanger fouling monitoring

- calculate heat transfer + fouling continously
- alert on limit values
- common module for several types of HX

Challenge #1: linking data / fast deployment

Asset information is distributed over many data sources → how to link it for fast roll-out?



Covestro Use of Emerson Delta V

With annual sales of more than 12 billion euros and almost 16,000 employees, polymer maker Covestro has 30 sites across Europe, Asia and America, eight of them production facilities. “We’ve been making polymers since the 1930s,” said Rich Guhl, director of global process automation.

“We develop state-of-the-art polymer materials that can do more. We help to push boundaries by supplying innovative and sustainable products, technologies and solutions for key industries and modern life. We think we can make the world a better place by doing what we do best.”

Guhl shared his company’s journey into data leverage and the Industrial Internet of Things (IIoT) during at the Emerson Global Users Exchange. Covestro is organized in three divisions. The polyurethanes division makes the raw materials for rigid and flexible foams. Polycarbonates sells granules and sheets for a wide variety of applications. The coatings, adhesives and specialties division manufactures more than 2,600 different materials. Plus, Covestro supplies basic chemicals for its own operations, producing enough chlorine to make it one of the world’s leading chlorine producers, explained Guhl.

Rich Guhl, Director of Global Process Automation , Covestro

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Covestro Challenges

- Covestro faces five big challenges along the value chain as a result of its European location.
- First is the feedstock disadvantage. “If you go to the Gulf Coast or the Middle East, you see an abundance of feedstock,” said Guhl, “but not in the EU.”
- Because of the feedstock locations, the chemical industry clusters outside of the European Union, where feedstock is more readily available.
- EU regulations for the chemical industry have increased by 56% since 2008, driving up costs in Europe and creating an uneven international playing field, especially compared to China and the Middle East, explained Guhl.
- The EU's manufacturing base is shrinking. “Our products go to other manufacturers,” explained Guhl. “When they’re disappearing, that’s a disadvantage to us.”
- There’s also been a shift in demand. “Our products are expected to be more sustainable and environmentally friendly,” he said.

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Digital Manufacturing Approach at Covestro

Covestro's approach to digital manufacturing started with three horizons of implementation.

- Optimize supply. “We wanted to innovate how we do daily business, from predictive maintenance and end-to-end supply chain,” said Guhl.
- Leverage growth. “Then we had to innovate how customers do business with us,” explained Guhl. “For the customer experience and channels, it meant getting more in tune with customers.”
- Start a new game. “We needed to make business models digitally enabled,” said Guhl. “How would Google run our business?”

To optimize supply, Covestro needed to put data into context and make it actionable, with an initial focus on three categories of data-driven improvement aimed at reducing costs, ensuring safety and increasing uptime/improving quality. “If we can accomplish this, it will enable end-to-end supply chain and improve our own operation. Standardization and strong partnerships are the foundation.” Emerson is one of the key partners for Covestro’s process automation, he explained.

Covestro has created partnership models with varying levels of value delivery. Lower-level partnerships typically are asset-focused, while higher-level partnerships encompass plant or system performance. Further, Level 1 partnerships might rely on break-fix maintenance, while Level 2 represents on-premise maintenance services. Level 3 includes connected services via IIoT, and Level 4 outcome-based services.

“At some plants, we’re not ready to move up, so we have a joint program with Emerson to migrate to DeltaV, and then we can upgrade to more system-based performance increases,” explained Guhl. “Our long-standing wish list includes plug-and-play for devices and package units; seamless data integration; auto-updated plant documentation; built-in IT security; sharing data and services beyond own enterprise; and leveraging joint expertise of Emerson and Covestro.”

People, Projects and Plant Data

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New Marketing Environment Created by IIoW and IIoT

The coming generation of decision makers are accustomed to speedy digital information transfer.

An example of this potential is a McIlvaine webinar to help power plants choose gypsum dewatering equipment. Andritz made a presentation to an audience who included a Michigan utility which had to make a quick decision. The Andritz basket centrifuge uniquely fit their needs . They purchased the first basket centrifuge for gypsum dewatering at a U.S utility without any of the normal sales calls.

Mcilvaine has created decision systems for all flow and treat equipment and services for power plant owners Similar services should be set up for each industry

Mcilvaine took IIoT to the next level by creating a system for one large utility 4S01 Berkshire Hathaway Energy Supplier and Utility Connect. This paves the way for suppliers to demonstrate how their products and services are or will be needed at multiple pants

Similar systems should be created for the 20 largest chemical companies

- This effort will be very cost effective due to the availability of new digital information
- The Dow examples which follow show the available digital information on processes within each plant
- The BASF people example shows the ease of reaching all the right decision makers
- The BASF project information shows the availability of data about large new projects

IIoT will be generating millions of instant digital white papers about the performance of components and processes. Sales promotion will become less valuable whereas extracting the IIoT wisdom and conveying it will be the road to success in this new digital environment

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LinkedIn Contacts at BASF

Name	Title	Location	IIoW Activity
Suhren, Hogel	Head Valve Procurement	DE	Valve sourcing, activities described in Mar 16 Valve World article on development of world bidders list
Spiegel, Guenter	Angestellter	DE	Valve engineering described in Apr 16 Valve World
Kinger, Andreas	Head of IIoT Lab	DE	
Huk, Matthias	Not LinkedIn	DE	Valve engineering described in Apr 16 Valve World
Kaiser, Andre	Not LinkedIn	DE	Valve maintenance described in May 16 Valve World
Klein, Wolfgang	Senior Engineering Manager	DE	Valve maintenance described in May 16 Valve World
Netzer, Frithjof	Senior V.P 4.0	DE	Netzer leads the digital transformation at BASF across divisions, regions and functions with the BASF 4.0 project
Luftus, Howard	Information Specialist	S. Africa	Upgraded SCADA systems as per subsequent slide
Duc	Junior specialist , process optimization	Schwarz-heide, DE	Participates in blog to convey optimization information to others
Jandall, Samy	V.P New Digital	DE	New digital business models at BASF 4.0 project
Meiller, Paul	Asset manger	Houston	Innovative engineer

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BASF LinkedIn Examples (continued)

Name	Title	Location	IIoW Activity
Biegen, John	Supply chain professional development program	San Diego	-Greatly improved data in SAP by creating 40+ new articles to prevent the deletion of essential materials, requiring the identification of the proper packaged weight, obtaining SDS, and packaging spec -Updated critical database used by product managers to reflect accurate and current data -Increased populated fields by ~42%, greatly improving integrity of database
Ciputra, Agus	Strategy	DE	Strategy and business excellence and past 4.0 activity
Moors, Jurgen	Team leader	Belgium	Team leader Technical Verbund Management
Ravinutala, Pavan Kumar	Senior Manager	DE	Head of project management-applications and processes
Briggs, Bobby	Director of 'engineering design services	Houston	Provide support for large Capital Projects executed in North America by planning, assembling, and managing resources.
Craig, Shanon	SAP plant manager	NYC	
Motamedi, Mohammod	Plant Manager	Detroit	P&L responsibility , chemical Processing (Batch & Continuous), multiple site manufacturing leadership, Safety performance Mgmt , supply Chain optimization, strategic Planning ,
Caro, Jose, Fernandez	Plant Manager BASF coatings	Madrid	long-standing and broad experience in a whole range of fields in Operations Management such as Engineering, Maintenance and last but not least Production.
Gong, Yihong	Director	China	Director of Project Engineering and Maintenance Asia Pacific
Lican, John	VP Operations	Beaumont	Methane to polypropylene
Kimmit, Jack	Director of Project Development	Houston	Responsible for the conceptual planning for Large Capital Projects in NA. Led Group of ~40 professionals consisting of Engineering Managers, Process Engineers and Project Engineers.

Netzer leads the Digital Transformation at BASF across Divisions, Regions and Functions with the BASF 4.0 Project

Becoming the Factory of the Future: How to prepare now for the Industrial Internet of Things

"At BASF, we create chemistry - and have been doing so for more than 150 years. As the world's leading chemical company, we combine economic success with environmental protection and social responsibility. Through science and innovation we enable our customers in nearly every industry to meet the current and future needs of society." Frithjof Netzer leads the digital transformation at BASF across divisions, regions and functions with the BASF 4.0 project. Digital core technologies such as internet of things, big data analytics, mobility devices and augmented reality are systematically merged with BASF's value chain. This includes procurement, supply chain, logistics, engineering, manufacturing, marketing & sales and innovation. Based on this BASF adds value to customers through digitally enabled products and services. Horizontal and vertical connections are used to increase effectiveness and efficiency of customer and supplier interactions. Frithjof joined BASF in 1999 and held a variety of business and procurement leadership roles in coatings, hygiene, petrochemicals and performance chemicals. His jobs were located in Münster / Germany, Mt. Olive, NJ (USA), Charlotte, NC (USA), Ludwigshafen / Germany and Hong Kong. He holds a doctoral degree in business administration from the University of Münster, Germany based on research work in the airline industry.

The Internet is the prevailing medium of digital communication worldwide. However, the concept of using instant, pervasive, and globally connected data over the Internet for the benefit of industrial manufacturing is still in its theoretical stages, with few Internet-friendly industrial technologies actually available in the market to put the concept into practice. For factories of the present, the ability to compete in tomorrow's economy hinges on their ability to integrate with this Industrial Internet of Things.

Frithjof Netzer
Senior Vice President, BASF 4.0
Speaker at Industry of things World 2017

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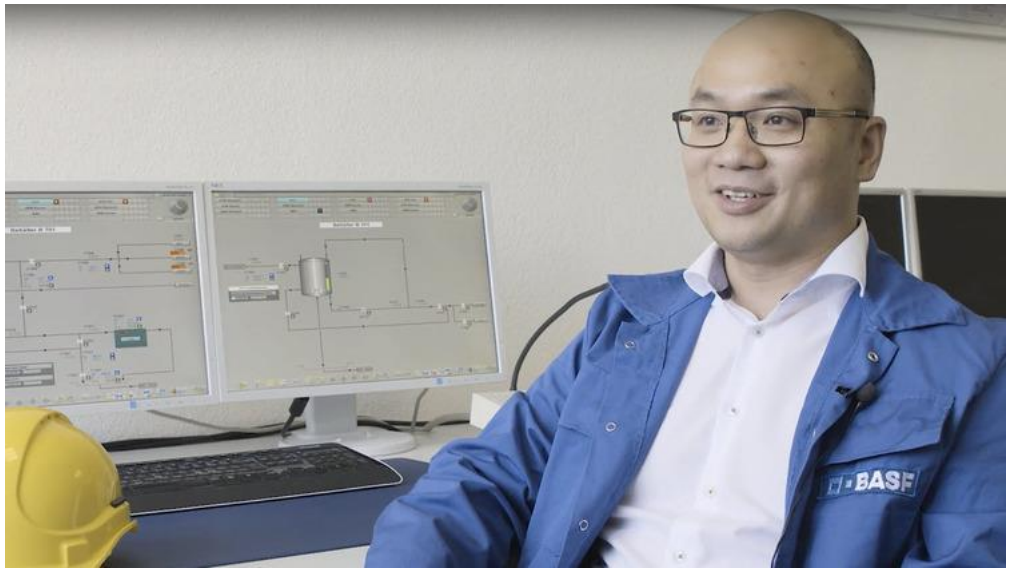
BASF has Blogs to Provide Interconnection

As Junior Expert for Process Optimization, I improve production processes for example by avoiding by-products and by saving energy. When I or somebody else has an idea, I will investigate as a small project, calculating the numbers and then pitch to my superiors. If they are convinced, I will test my assumptions in a pilot project, and then later in the larger process facilities together with the plant operators.
I am also very involved with developments linked to the introduction of „industry 4.0“. We are starting to use Augmented Reality and can soon, similar to „Pokemon Go“, display information directly on the chemical plant. The worker uses the smartphone or tablet, the camera „understands“ what it sees and the display shows manuals, measurements, or other data directly at the right part of the plant. This helps especially with maintenance and educational tasks. Also, processes are getting even more digitalized and we can optimize the plants even more thanks to more measurement data – saving raw materials and therefore energy and reducing the environmental footprint. Luckily, these optimizations do not cost jobs – just as smartphone apps do not replace the person who is calling.
Of course, there is not always budget or time for all the ideas. The production cannot always be interrupted, plants can not be rebuilt or reconfigured immediately. But my work is always inspiring and diverse, and I get to develop new Ideas with my colleagues every day to become even better.



Duc is a junior expert for Process Optimization and working on Industry 4.0

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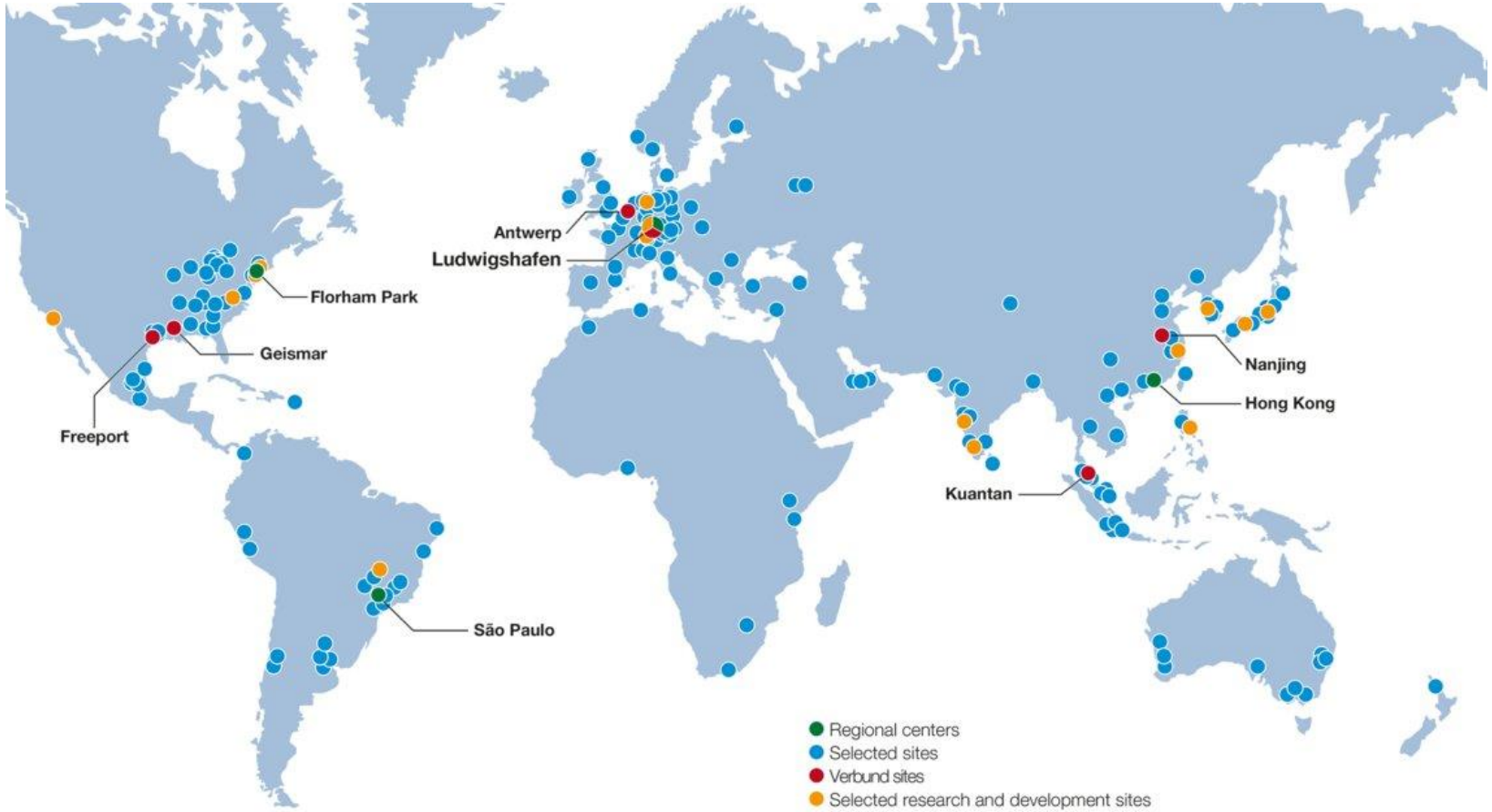
BASF Plant Locations



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New BASF MDI Project at Geismar, LA

- BASF SE has announced plans to increase capacity for MDI at its plant in Geismar, LA, from 300,000 metric tons per year to 600,000 in a series of steps beginning in 2020 to the middle of that decade.
- “Engineering for the capacity increase has already started,” said Stefano Pigozzi, president of BASF’s monomers division. “Subsequent steps will be implemented aligned with business development. MDI precursor units in Geismar will be expanded accordingly.”
- Construction is scheduled to start in mid-2018, the company said, and the plan is for a gradual, step-wise increase until capacity is eventually reached. BASF's global headquarters is in Ludwigshafen, Germany.
- Stefan Doerr, head of the monomers business unit in North America said: “Our infrastructure at Geismar, combined with competitive raw materials based on shale gas make Geismar ideally suited for the investment.” BASF said that these could be sourced internally, or “the market could supply all relevant materials locally based on competitive shale gas feeds or globally.”
- Pigozzi added that his firm will use the latest proprietary technologies that will ensure best-in-class productivity and energy efficiency.

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New Large Project Information Needs to be Shared by Many

- BASF Beaumont unveiled its $270 million dicamba production expansion in March 2017.
- "The Beaumont plant is the only dicamba herbicide manufacturing facility in the U.S.," Ward Senior Vice President Lynn A. Hancock wrote in an email to The Enterprise. "Dicamba effectively controls more than 200 broadleaf weeds and is the fifth most widely used herbicide in the U.S. It was used on more than 35 million acres in 2015."

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New Project Examples, continued

- Citing increased industrial demand, German chemical company BASF has announced plans to expand capacity at its plant in McIntosh, Ala.
- The company announced in November 2016 that it was spending more than $200 million ramping up its worldwide production of plastic additives. The McIntosh site is one of the facilities involved; a company representative said BASF would not reveal what portion of the money was earmarked for it.
- LaShaundra Garrett Holly, communications manager for BASF's southeast regional communications hub, said the company didn't expect an immediate increase in jobs at the plant, which employs more than 600 people. More hiring could be a possibility in the future, however, she said. According to information provided by Holly, the plant is "currently in the midst of many projects which have already yielded increased production capacity and improved asset reliability."
- BASF made clear that its move is based on expectations of industrial growth. "Low-priced natural gas feedstock enticed many large petrochemical companies to construct new plants and expand operations in North America."

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Recent BASF Expansion in South America

- In 2015 – BASF inaugurated its world-scale production complex for acrylic acid, butyl acrylate and superabsorbent polymers in Camaçari, Bahia, Brazil. These are the first plants for acrylic acid and superabsorbent polymers in South America. The complex has a capacity of 160,000 tons of acrylic acid per year. The investment of more than €500 million is the largest in BASF's more than century-long history in South America.
- In 2012 BASF began operations at a new world-scale production plant for sodium methylate in Guaratinguetá, Brazil. With a capacity of 60,000 metric tons per year it is its largest site in South America. It is the first BASF plant for this product in South America and the second in the world, in addition to a plant in Ludwigshafen, Germany. Capital expenditure for the project was in the low double-digit million euro range.
- In 2013 BASF announced more than €50 million in investments to expand its crop protection production capacities in the Guaratinguetá chemical complex, about 170 kilometers from São Paulo, Brazil. As result, the company will increase local production and formulation capacities of its latest blockbuster products. Another positive consequence of the investments is the creation of 70 new jobs. Furthermore, a new plant for biological products is scheduled to be opened by August this year in Chile. These products will add further value to the portfolio of the company's recently established business unit Functional Crop Care.

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BASF South Africa Upgrades SCADA Systems with Wonderware

Previously, the InTouch SCADA assets at BASF's Port Elizabeth Mobile Emissions Catalyst plant were based on stand-alone systems running under-specified PCs," says Howard Loftus, information management specialist, BASF South Africa. "This presented a high risk of failure because of the lack of redundancy and also a maintenance challenge because these individually managed PCs would all be running different software revisions. So if one failed and was replaced, it wasn't always with the same software version and this would lead to costly downtime.

BASF converted their InTouch licenses to InTouch for Terminal Server versions and purchased ACP ThinManager (mirrored – ie, master and redundancy configuration). This would provide double redundancy through application and physical layers. The project was to be implemented over two phases. The first (completed at this time of documenting) consisted of:

* Converting the critical applications to the Terminal Server.

* Converting the remaining, less complicated, applications to Terminal Server.

- Implementing critical application redundancy.

Business benefits

- * Reduced maintenance cost and time – Industrial clients are low on maintenance since failed units are simply replaced by working ones. No configuration is necessary.
- * Decrease in production losses – "On two occasions the redundancy server kicked in over a weekend and no one was aware of this until Monday morning. Just these two instances resulted in significant cost saving ," says Loftus. "There is no doubt that robust client hardware with applications running in a secure server environment is making a difference."
- * Lower cost computer hardware – Previously, PCs that failed because of environmental conditions were repeatedly replaced. "Because of their robust nature, we haven't yet had to replace a thin client," comments Loftus.
- * Reduced total cost of ownership – This is mainly due to reduced servicing, maintenance and power costs.

Operational benefits

- * Reduced downtime which ultimately minimizes production losses in a very critical and expensive production process. So far, this has been the largest cost saving.
- * Increased security – Centralized deployment of applications, patches and anti-virus software etc. are all done on the servers. Users cannot introduce viruses, worms or other malware through the thin clients because there is no physical way of doing so.

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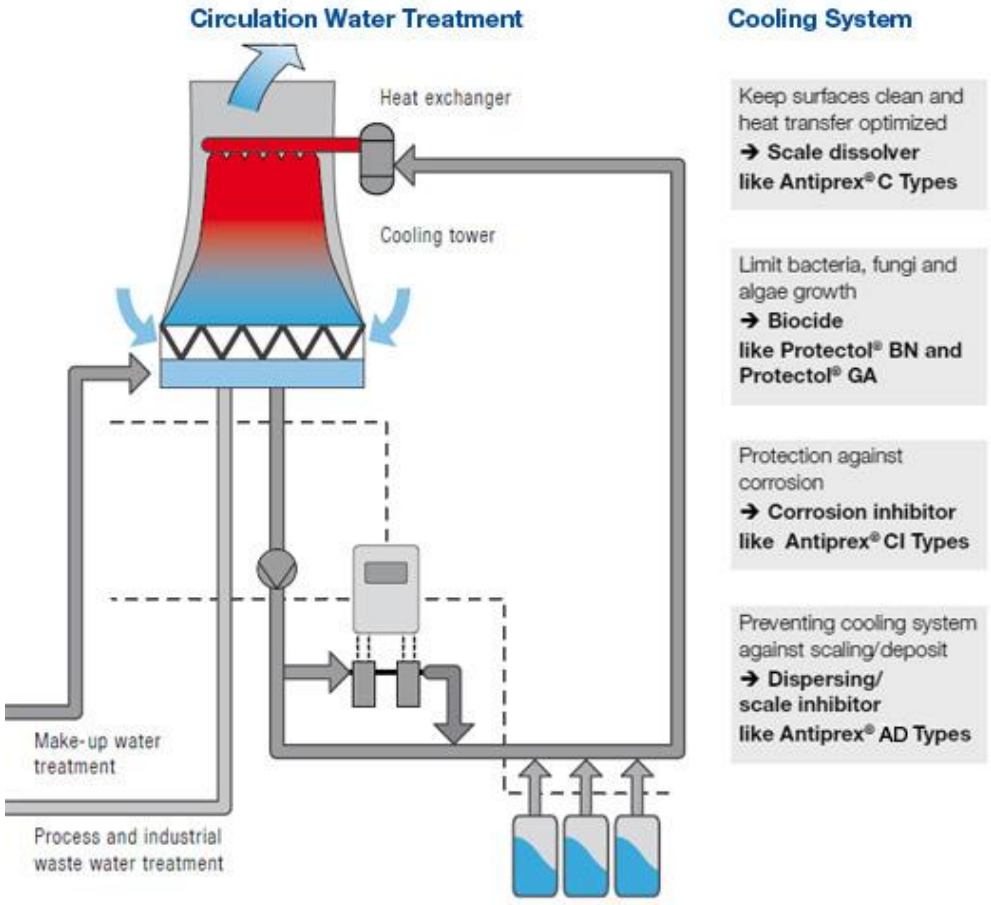
BASF Supplies Treatment Chemicals to the Chemical Industry

BASF is a major supplier of treatment chemicals for water and wastewater. In the chemical industry it supplies chemicals for boiler feedwater, cooling water, intake water, and wastewater. It also contracts to dispose of city wastewater in at least one location

BASF's wastewater treatment plant is one of the largest in Europe and the largest wastewater treatment plant on the Rhine: It purifies a volume of water that would be created by some three million people in private households.

Almost 100 million m^3 of production waste water from BASF is purified here annually. The plant also purifies another 20 million m^3 of waste water from the cities of Ludwigshafen and Frankental, as well as from the Bobenheim-Roxheim municipality.

The interconnection between people within different divisions is important . BASF can leverage the IIoT knowledge from its operating plants with the IIoT knowledge of its product groups.



Dow Plants Listed in McIlvaine's *Industrial Plants and People*

- DOW AGROSCIENCES LLC - HARBOR BEACH, MI
- DOW CHEMICAL CO - CHARLESTON, IL
- DOW CHEMICAL CO - LUDINGTON, MI
- DOW CHEMICAL CO - MARIETTA, GA
- DOW CHEMICAL CO - PEVELY, MO
- DOW CHEMICAL CO - PITTSBURG, CA
- DOW CHEMICAL CO - TEXARKANA, AR
- DOW CHEMICAL CO - WILMINGTON, IL
- DOW CHEMICAL CO RUSSELLVILLE - RUSSELLVILLE, AR
- DOW CHEMICAL CO CLEAR LAKE OPERATIONS - PASADENA, TX
- DOW CHEMICAL CO DALTON PLANT - DALTON, GA
- DOW CHEMICAL CO DOW AUTOMOTIVE HILLSDALE - HILLSDALE, MI
- DOW CHEMICAL CO FREEPORT FACILITY - FREEPORT, TX
- DOW CHEMICAL CO GENERAL LATEX & CHEMICAL CORP - RANCHO CUCAMONGA, CA
- DOW CHEMICAL CO GRAND BAYOU OPERATIONS - PAINCOURTVILLE, LA
- DOW CHEMICAL CO LA PORTE - LA PORTE, TX
- DOW CHEMICAL CO LOUISIANA DIV - PLAQUEMINE, LA
- DOW CHEMICAL CO MIDLAND OPERATIONS - MIDLAND, MI
- DOW CHEMICAL CO PENNSAUKEN - PENNSAUKEN, NJ
- DOW CHEMICAL CO TORRANCE FACILITY - TORRANCE, CA
- DOW CHEMICAL ISO PLANT TRACY CA. - TRACY, CA
- DOW CHEMICAL JOLIET SITE - CHANNAHON, IL
- DOW CHEMICAL USA HANGING ROCK PLANT - IRONTON, OH
- DOW CORNING CORP - CARROLLTON, KY
- DOW CORNING CORP - ELIZABETHTOWN, KY
- DOW CORNING CORP - GREENSBORO, NC
- DOW CORNING CORP - MIDLAND, MI
- DOW CORNING CORP AUBURN SITE - AUBURN, MI
- DOW CORNING CORP HEALTHCARE INDUSTRIES MATERIALS SITE - HEMLOCK, MI
- DOW HALTERMANN PLANT 1 - HOUSTON, TX
- DOW HALTERMANN PLANT 2 - CHANNELVIEW, TX
- DOW N.A. ALLYN'S POINT PLANT - GALES FERRY, CT
- DOW REICHHOLD KENSINGTON PLANT - CHICKAMAUGA, GA
- DOW REICHHOLD SPECIALTY LATEX LLC - DOVER, DE

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Dow Water Discharges from *Industrial Plants and People*

Company Name: DOW CHEMICAL - PLAQUEMINE

Address1: P.O BOX 150, **Address2:** PLAQUEMINE PARISH

City: PLAQUEMINE **State:** LA

ZIP Code: 707650150 **county:** IBERVILLE

Official Representative: EARL SHIPP **Official Representative Telephone Number:** 5043538111

Mailing Company Name: DOW CHEMICAL - PLAQUEMINE

Mailing Address1: PO BOX 150

Mailing Address2: PO BOX 150

Mailing City: PLAQUEMINE

Mailing State: LA

Mailing ZIP Code: 70764

SIC Code: 2869

SIC Description: INDUST. ORGANIC CHEMICALS NEC

Flow Rate: 550 mgd

Industrial Classification: P

Industrial Classification Description: PRIMARY ON EFFLUENT LIMITATION GUIDELINES

Discharge: major

Company Name: DOW CHEMICAL PITTSBURG

Address1: NORTHEND LOVERIDGE ROAD

City: PITTSBURG, **State:** CA

ZIP Code: 94565, **county:** CONTRA COSTA

Telephone Number: 5104325122

Official Representative: MR. MARK GARIBALDI

Official Representative Telephone Number: 9254325101

Mailing Company Name: DOW CHEMICAL, USA - PITTSBURG

Mailing Address1: PO BOX 1398

City: PITTSBURG **State:** CA

Mailing ZIP Code: 945650398

SIC Code: 2819

SIC Description: INDUSTRIAL INORGANIC CHEMICALS

Flow Rate: 0.5 mgd

Industrial Classification: P

Industrial Classification Description: PRIMARY ON EFFLUENT LIMITATION GUIDELINES

Discharge: major

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Dow Plaquemine Industrial Boilers/Heaters

Also from Industrial Plants and People

Facility Name: Dow Chemical, Louisiana Operations, Vinyl
Address: 2Plaquemine, Louisiana 70764 **County:** Ibervill e

Primary Contact Name: Bob Brady Sr. Environmental Specialist

Telephone: 225-353-8270, **Fax:** 225-687-8001

E-mail: bbrady@dow.com

- **Unit ID:** F-101 *Click on Unit ID to view Emissions Data*
- **Classification:** Process Heater
- **Year Installed:** 1975
- **Capacity Mil Btu/hr:** 75.3
- **Operating Hrs/Yr:** 8760
- **Fuel:** Natural gas

This Mcilvaine database has data on 30,000 industrial boilers in the U.S.

Unit ID: F-102 *Click on Unit ID to view Emissions Data*
Classification: Process Heater
Year Installed: 1975
Capacity Mil Btu/hr: 75
Operating Hrs/Yr: 8760

Unit ID: F-103 *Click on Unit ID to view Emissions Data*
Classification: Process Heater
Year Installed: 1975
Capacity Mil Btu/hr: 75
Operating Hrs/Yr: 8760
Fuel: Natural gas

Unit ID: F-104 *Click on Unit ID to view Emissions Data*
Classification: Process Heater
Year Installed: 1975
Capacity Mil Btu/hr: 75
Operating Hrs/Yr: 8760
Fuel: Natural gas

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