

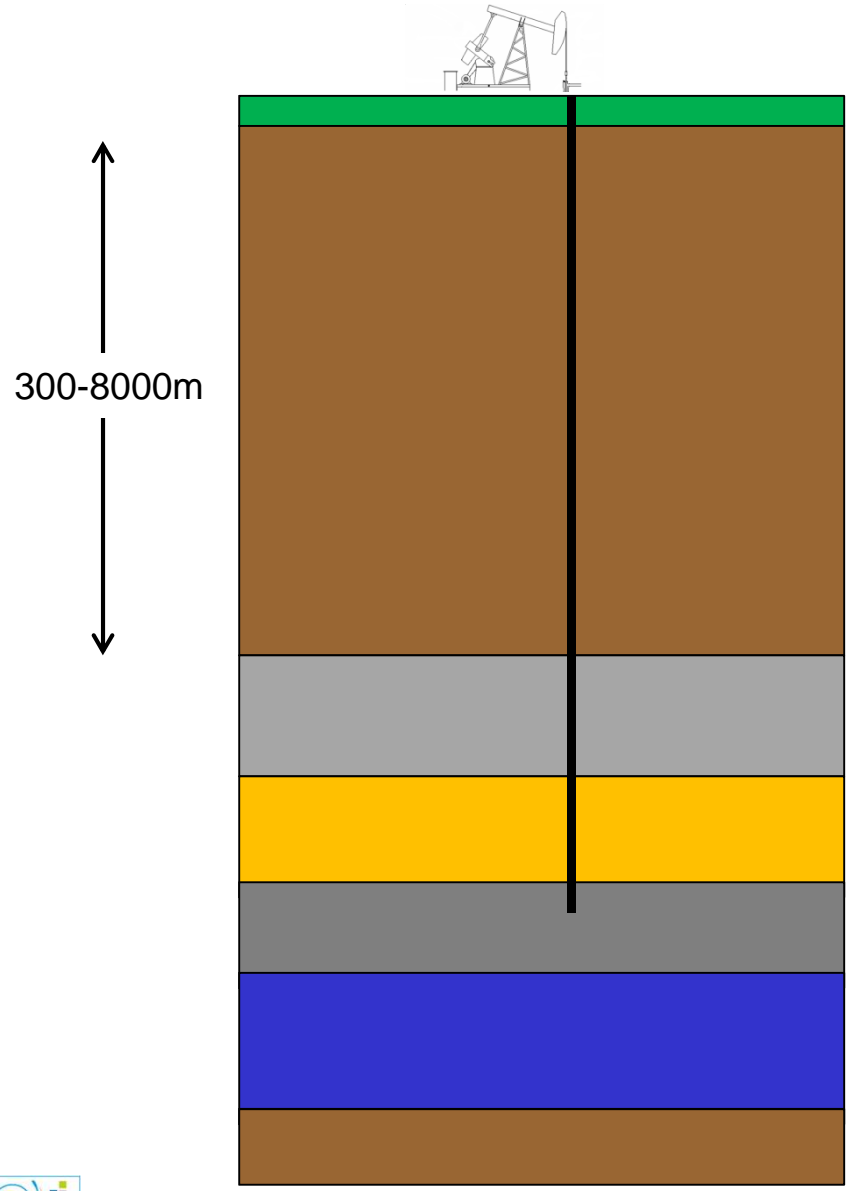
Efficiency Gains Related to Chemical Treatments in Oilfield Production - Resulting from Applying Systems Architecture

Alan F. Krauss
Schneider Electric

Agenda

- Introduction
 - Oilfield Production Scenario
 - Production Expenses
 - Rod Pump Controllers and Drives
- Stakeholders & Expected Feature Analysis
 - Needs
 - Requirements
- Operational Analysis
 - Use Case, Response Scenario
- Functional Analysis
 - Requirements Revisitation, I/O Diagram
- Constructional Analysis
 - Requirements Revisitation, Interfaces
- Conclusion

Where is the Oil?



surface

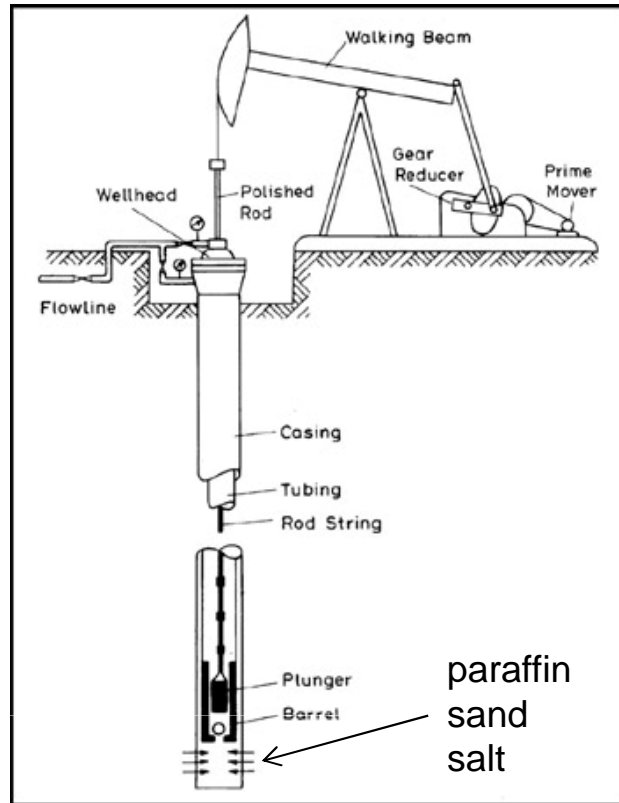
anticline
(impervious shale or limestone)

shale seal or cap rock

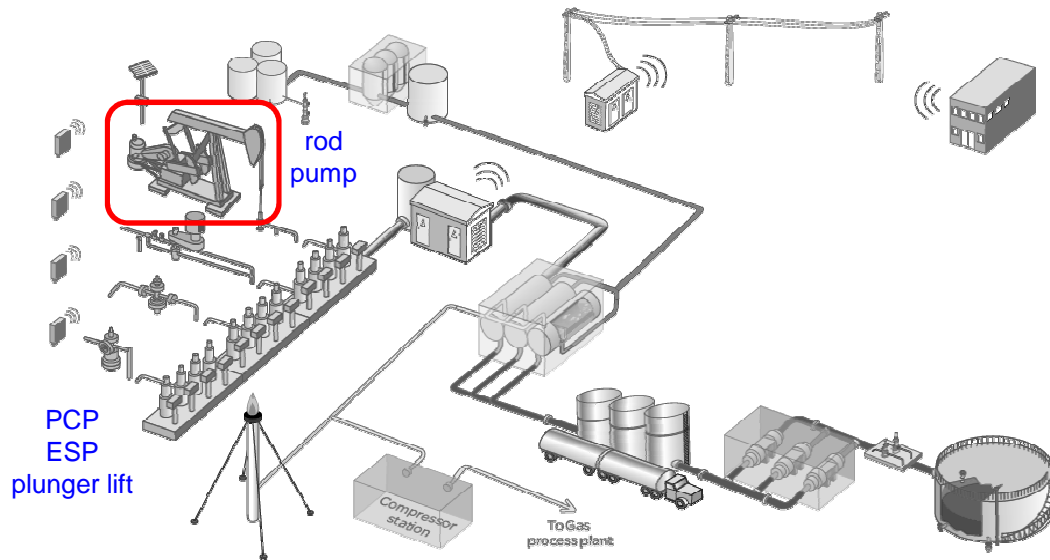
gas in permeable rock

oil in permeable rock

water in sandstone



Rod Pump Controller (RPC) Environment



Main Mission (for Producer):

Extract resource (oil and/or gas) out of the ground with
sales \$ € ¥ > cost \$ € ¥

Oil Producer Issues:

1. Maintenance and downtime costs associated with equipment
2. Producing the most oil when running
3. Minimizing expenses when running (energy, byproduct generation)
4. Too many wells, not enough people



RPC Solution Components



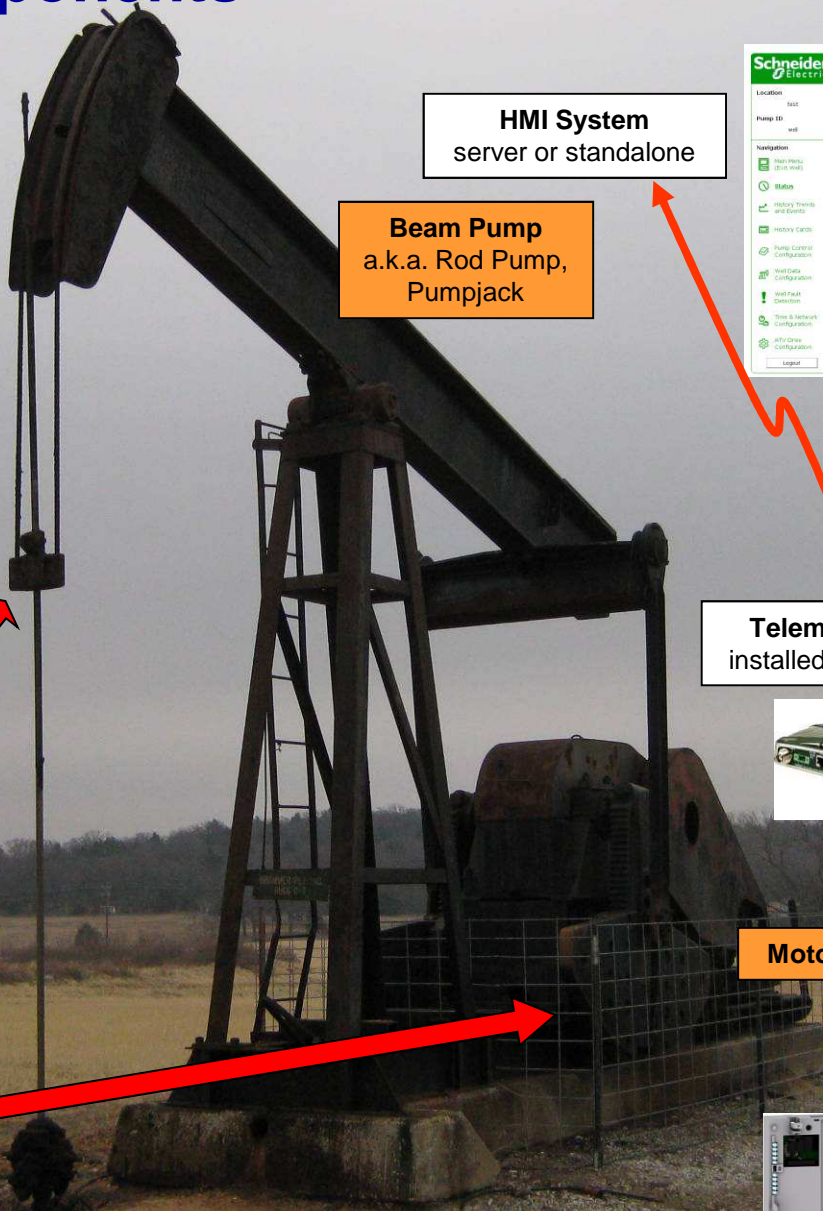
Wireless/Wired Sensors
installed on pipes,
tanks, etc.



Load Cell Sensor
installed on bridle



Proximity Sensor
mounted behind crank arm

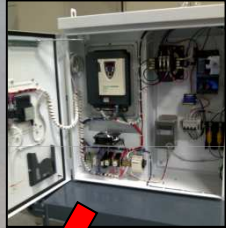


HMI System
server or standalone

Beam Pump
a.k.a. Rod Pump,
Pumpjack



Drive Enclosure
mounted near well



Telemetry/Radio
installed in enclosure

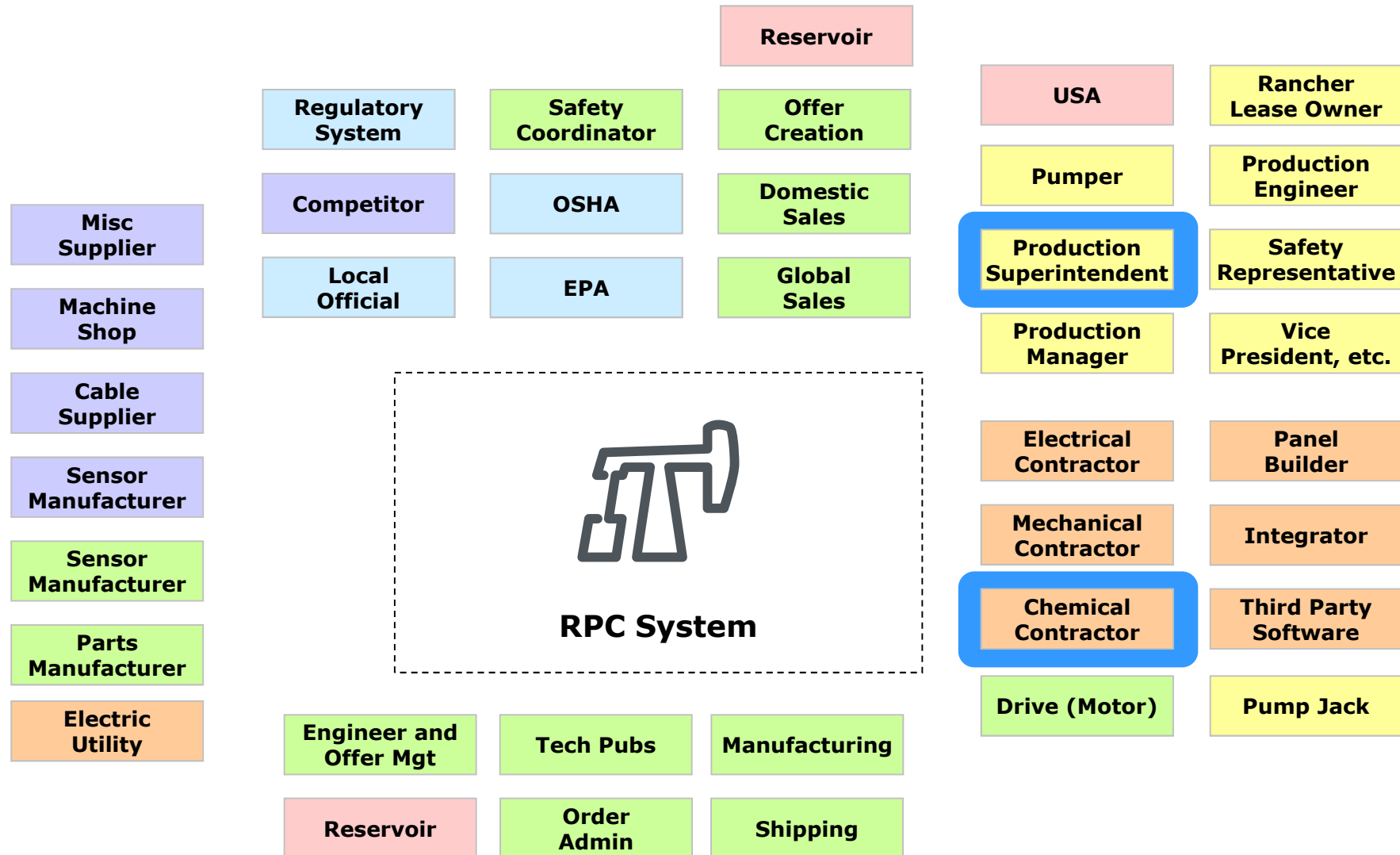


Motor

Integrated Machine Controller
for ATV71 Drive



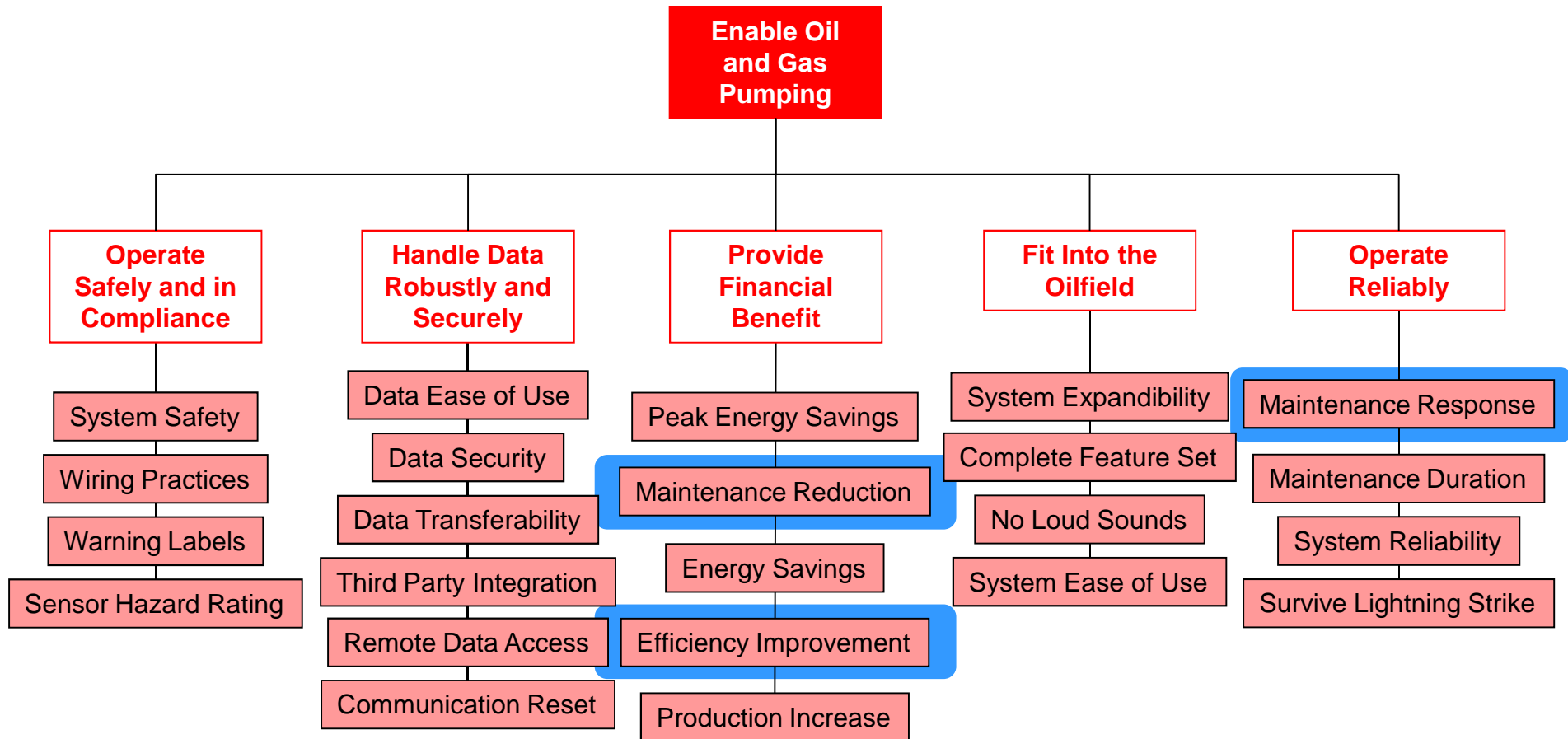
Stakeholders



In this paper, we focus on two Stakeholders in particular...

Expected Feature Analysis (1 of 3)

- General Needs Analysis



In this paper, we focus on three Needs in particular...

Expected Feature Analysis (2 of 3)

- Needs Analysis

The **Production Superintendent** shall be able to:

1. take **corrective action** to prevent loss of production within 48 hours of the onset of **excessive paraffin buildup** during normal operation.
2. minimize **chemical treatment production expenses** during normal operation.
3. save **time in daily routines by 10%** in order to be able to manage more wells in normal operation.

The **Chemical Contractor** shall be able to:

4. supply chemical treatment when requested **within 24 hours of a request being made** during normal operation.
5. save **time in daily routines by 10%** in order to be able to service more wells in normal operation.

Normal Operation = well is operational (not down for maintenance), there is no emergency at another well consuming Prod. Superintendent's time, daily duties are being performed, requests are being made and received.

Expected Feature Analysis (3 of 3)

- Requirements Analysis

Functional

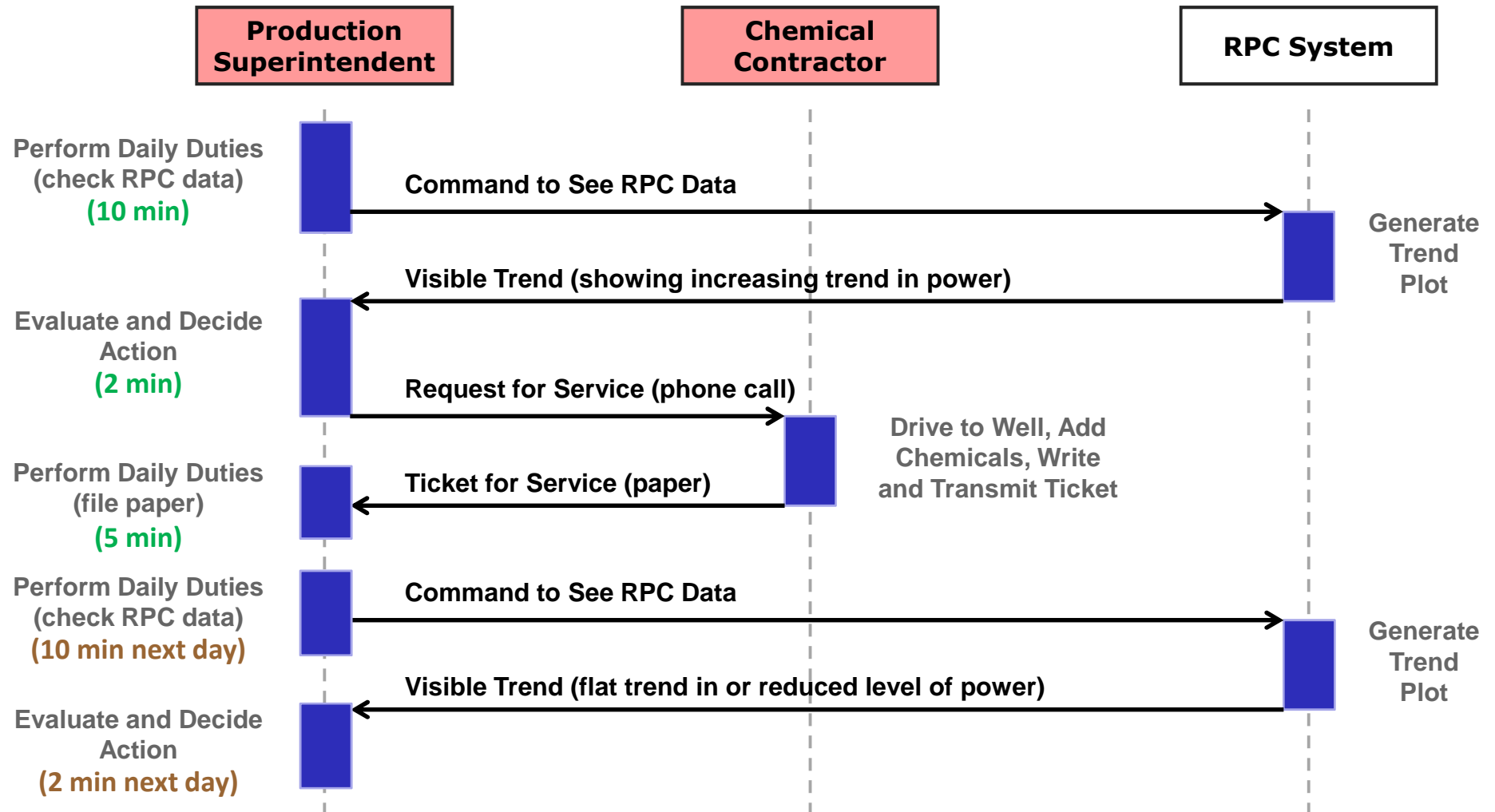
The **RPC System** shall:

1. display a **trend chart of the power** it takes to drive the rod string with **1% resolution** in collective and offline modes.
2. enable the user to **view a trend chart within 30 seconds** of engaging the HMI (Human Machine Interface) client in collective and offline modes.

Constructional

3. The **RPC Controller** shall **locate power data** from (a) the drive's electrical power meter sub-system (b) the surface card and (c) the downhole card in **data type REAL registers with resolution of at least 0.1%** of the full horsepower/kilowatt range of the drive, in any installed configuration.
4. The **HMI System** shall **store and display trend information** for REAL data types with samples up to every **1 second and duration 12 months or more**, in any networked configuration.
5. The **HMI System** shall contain an interface that allows **zooming on trend charts, on both axes**, with no more than **15 seconds retrieve, zoom and seek time**, in any networked configuration.

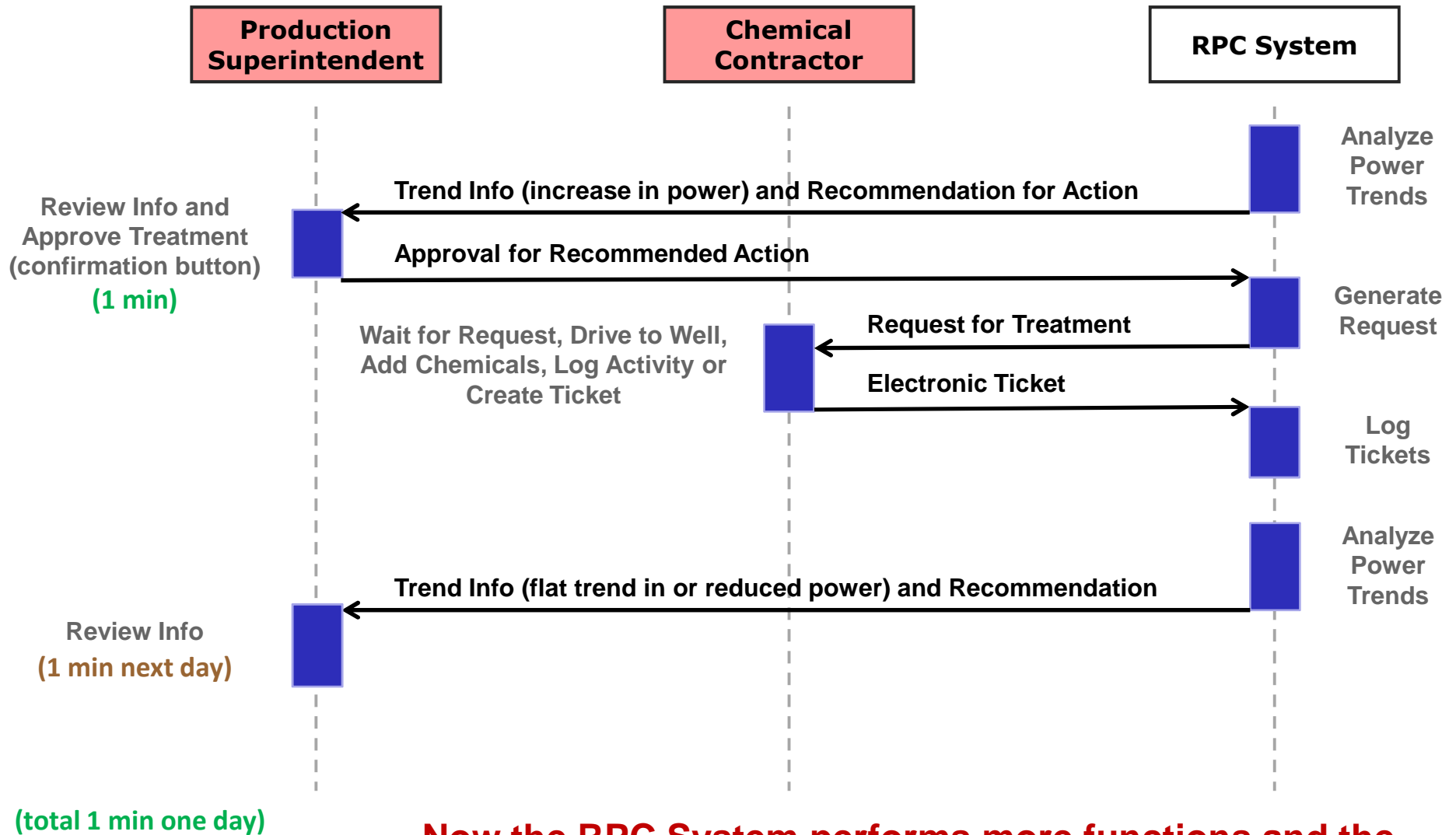
Operational Analysis: Response Scenario (1 of 2)



(total 17 min one day)

There are too many functions for the Production Superintendent to do!

Operational Analysis: Response Scenario (1 of 2)

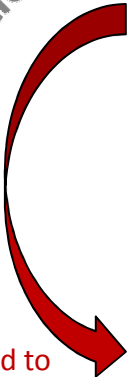


Now the RPC System performs more functions and the Production Superintendent has a more efficient day!

Functional Analysis: Requirements Revisitation

- Requirements Analysis

Functional



The **RPC System** shall:

- display a **trend chart of the power** it takes to drive the rod string with **1% resolution** in collective and offline modes.
- enable the user to **view a trend chart within 30 seconds** of engaging the HMI client in collective and offline modes.

The **RPC System** shall:

- provide **analysis of trends in the power** it takes to drive the rod string with **95% success rate** in collective and offline modes (with > 50% collective mode over time period).
- notify the user with **results and a summary of the power analysis** every day in collective and offline modes.

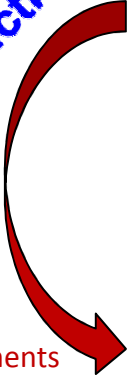
replace or add to requirements list (depends on the needs)

Functional Modes	HMI Server Active	HMI Server Inactive
RPC Active	Collective	Autonomous
RPC Inactive	Offline	Inactive

Constructional Architecture: Requirements Revisitation

- Requirements Analysis

Constructional



new requirements
to add to the list

(possibly remove
"and display" from
first requirement
depending on
functional
requirements)

4. The **HMI System** shall **store and display trend information** for REAL data types with samples up to every **1 second and duration 12 months or more**, in any networked configuration.
5. The **HMI System** shall contain an interface that allows **zooming on trend charts, on both axes**, with no more than **15 seconds retrieve, zoom and seek time**, in any networked configuration.
6. The **HMI System** shall **analyze trend information** for changes in power with sensitivity of at least **1% relative to daily, weekly and monthly averages**, in any installed configuration.
7. The **HMI System** shall contain an interface that allows **SMS, email and PC notification of trend analysis**, such that a user (or set of users) using a client device (or client devices) will receive **a clear, concise analysis report at a configured time each day**, in any networked configuration.

Operational Architecture: Interfaces & System Construction

SMS

Motor power has increased 7% since yesterday and 11% since last week.
Reply with text 'CHEM' to approve chemical treatment.

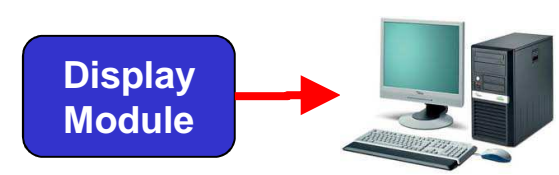
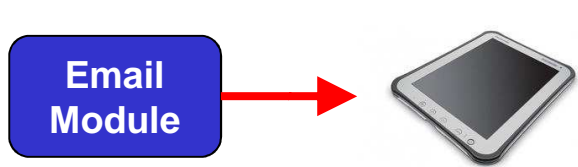
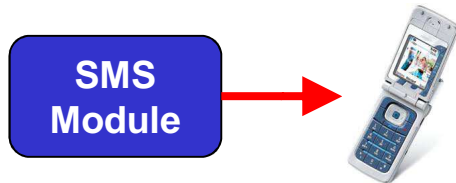
email

Motor power has increased 7% since yesterday and 11% since last week.

Would you like to send a request for treatment now?

Click 'Yes' or reply with 'CHEM' in the body of the email.

PC notification



Conclusion

- Stakeholder Analysis
 - A main issue (need) is efficiency of personnel
- Operational Analysis
 - Initial system design requires a lot of effort by oil producer personnel
 - Reworking the response scenario relieved time on the order of 15 minutes (3% of daily activity)
- Functional & Constructional Analysis
 - The system was redesigned to incorporate the efficiency gains
 - Components and their relation to the environment were specified
- Result
 - By applying systems architecture, a more robust and customer-centric system design was realized