Control Loop Monitoring and Performance Management

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Agenda

- SLOVNAFT and MOL GROUP
- Control Loop Monitoring - Theory
- Data Mining
- On-site Monitoring
- Applications and use case / How the PI System was applied?
- Implementation in the PI System

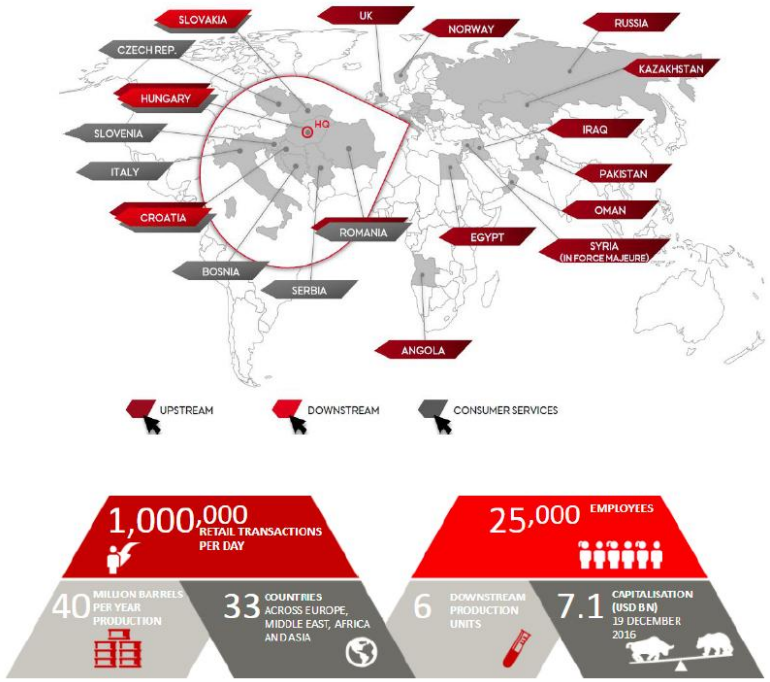
Control Loop Monitoring

- How the challenge has been solved by using other tools
- Results and business impact
- Implementation reports
- Conclusion

Performance Management

MOL Group

- MOL Group is an integrated, international oil and gas company, headquartered in Budapest, Hungary
- Active in over 30 countries
- International workforce of over 25,000 people
- Track record of more than 100 years in the industry



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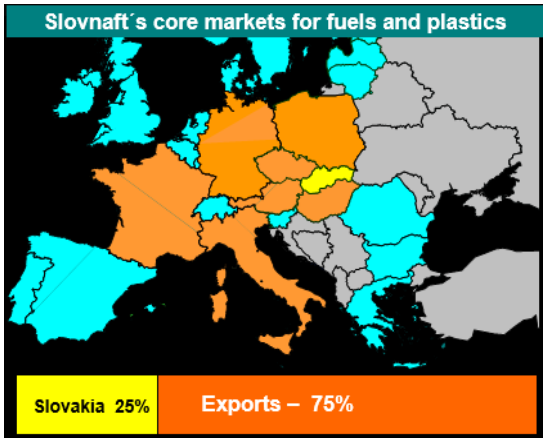
Actual data (2017)

Oil processing:	**5,6 mn t/a**
Key products:	
Motor fuels	**4,4 mn t/a**
Plastics	**406 kt /a**
Chemicals	**118 kt /a**

Employees: 2389 + 1046 (in filling stations)



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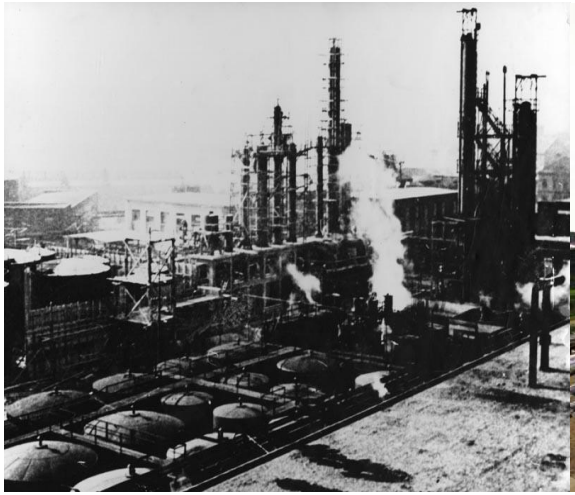
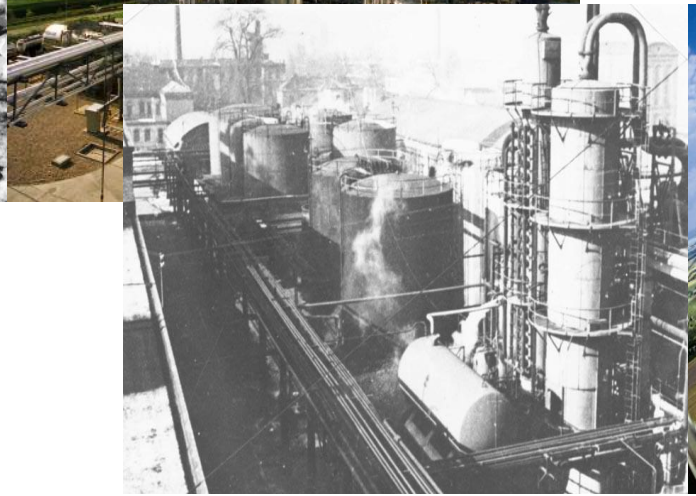




Control Loop Monitoring

- Idea is to detect degradations of control performance
- Identify and rectify the root-causes of control system problems
- Results of control problems, which can decrease the level of automation:
  - Unsafe, unstable, uneconomical manner, producing off-spec products, consuming more energy, losing profit making opportunities...

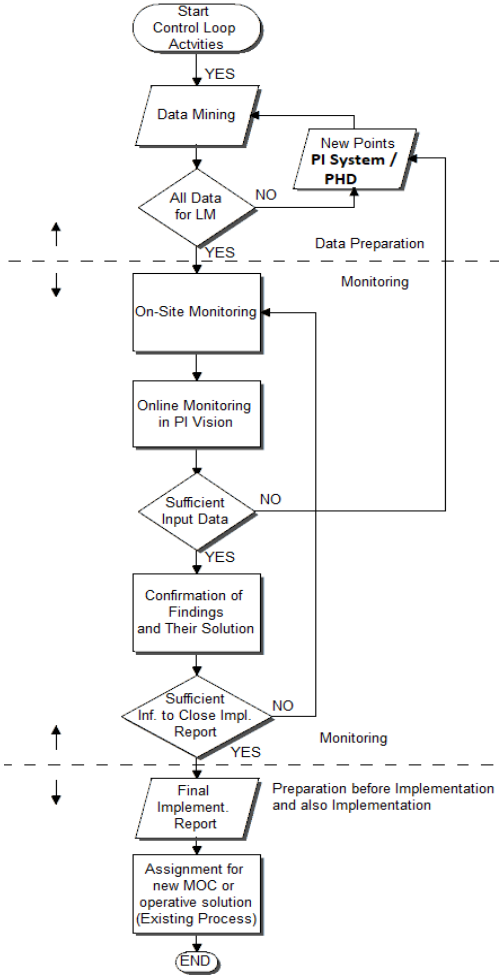
Control Loop Monitoring

- This is a continuous activity which should cover discrepancy between desired mode and actual mode (by operators).

- Based on the findings, our team is in charge of implementing changes. As we want to highlight this resolution and to take corrective actions, we need to have an on-line monitoring system.

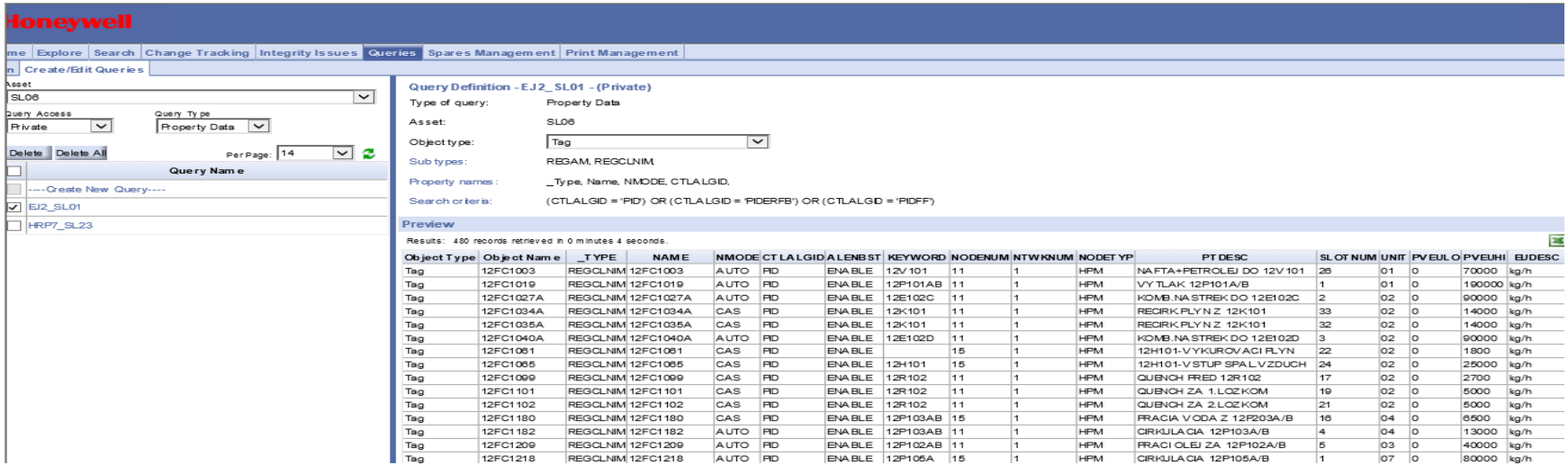
Flow Chart

LM – Loop Monitoring
PHD – Data Source (Honeywell)
MOC – Management of Change



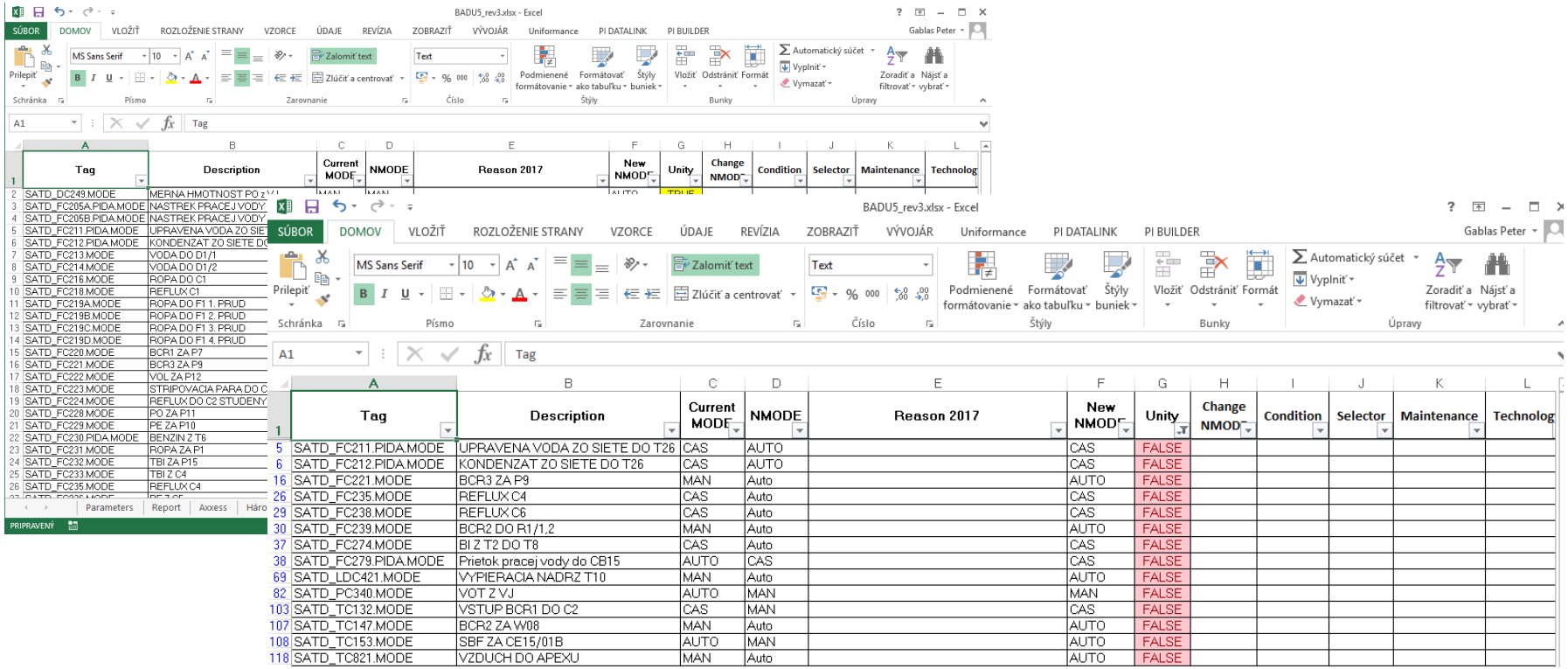
Data Mining

- Before starting the “Loop Monitoring” we do data mining (getting appreciated data from available sources: Asset management or controller export)



Object Type	Object Name	_TYPE	NAME	NMODE	CTLALGID	ALENBST	KEYWORD	NODENUM	NTWKNUM	NODETYP	PTDESC	SLOTNUM	UNIT	PVEULO	PVEUHI	EUDESC
Tag	12FC1003	REGCLNIM	12FC1003	AUTO	PID	ENABLE	12V101	11	1	HPM	NAFTA+PETROLEJ DO 12V101	26	01	0	70000	kg/h
Tag	12FC1019	REGCLNIM	12FC1019	AUTO	PID	ENABLE	12P101AB	11	1	HPM	VYTLAK 12P101A/B	1	01	0	190000	kg/h
Tag	12FC1027A	REGCLNIM	12FC1027A	AUTO	PID	ENABLE	12E102C	11	1	HPM	KOMB.NASTREK DO 12E102C	2	02	0	90000	kg/h
Tag	12FC1034A	REGCLNIM	12FC1034A	CAS	PID	ENABLE	12K101	11	1	HPM	RECIRK.PLYN Z 12K101	33	02	0	14000	kg/h
Tag	12FC1035A	REGCLNIM	12FC1035A	CAS	PID	ENABLE	12K101	11	1	HPM	RECIRK.PLYN Z 12K101	32	02	0	14000	kg/h
Tag	12FC1040A	REGCLNIM	12FC1040A	AUTO	PID	ENABLE	12E102D	11	1	HPM	KOMB.NASTREK DO 12E102D	3	02	0	90000	kg/h
Tag	12FC1061	REGCLNIM	12FC1061	CAS	PID	ENABLE		15	1	HPM	12H101-VYKUROVACI PLYN	22	02	0	1800	kg/h
Tag	12FC1065	REGCLNIM	12FC1065	CAS	PID	ENABLE	12H101	15	1	HPM	12H101-VSTUP SPALVZDUCH	24	02	0	25000	kg/h
Tag	12FC1099	REGCLNIM	12FC1099	CAS	PID	ENABLE	12R102	11	1	HPM	QUENCH FRED 12R102	17	02	0	2700	kg/h
Tag	12FC1101	REGCLNIM	12FC1101	CAS	PID	ENABLE	12R102	11	1	HPM	QUENCH ZA 1.LOZ KOM	19	02	0	5000	kg/h
Tag	12FC1102	REGCLNIM	12FC1102	CAS	PID	ENABLE	12R102	11	1	HPM	QUENCH ZA 2.LOZ KOM	21	02	0	5000	kg/h
Tag	12FC1180	REGCLNIM	12FC1180	CAS	PID	ENABLE	12P103AB	15	1	HPM	FRACIA VODA Z 12P203A/B	16	04	0	6500	kg/h
Tag	12FC1182	REGCLNIM	12FC1182	AUTO	PID	ENABLE	12P103AB	11	1	HPM	CIRKULACIA 12P103A/B	4	04	0	13000	kg/h
Tag	12FC1209	REGCLNIM	12FC1209	AUTO	PID	ENABLE	12P102AB	11	1	HPM	FRACI OLEJ ZA 12P102A/B	5	03	0	40000	kg/h
Tag	12FC1218	REGCLNIM	12FC1218	AUTO	PID	ENABLE	12P105A	15	1	HPM	CIRKULACIA 12P105A/B	1	07	0	80000	kg/h

Data Mining – Input Report (PI DataLink)



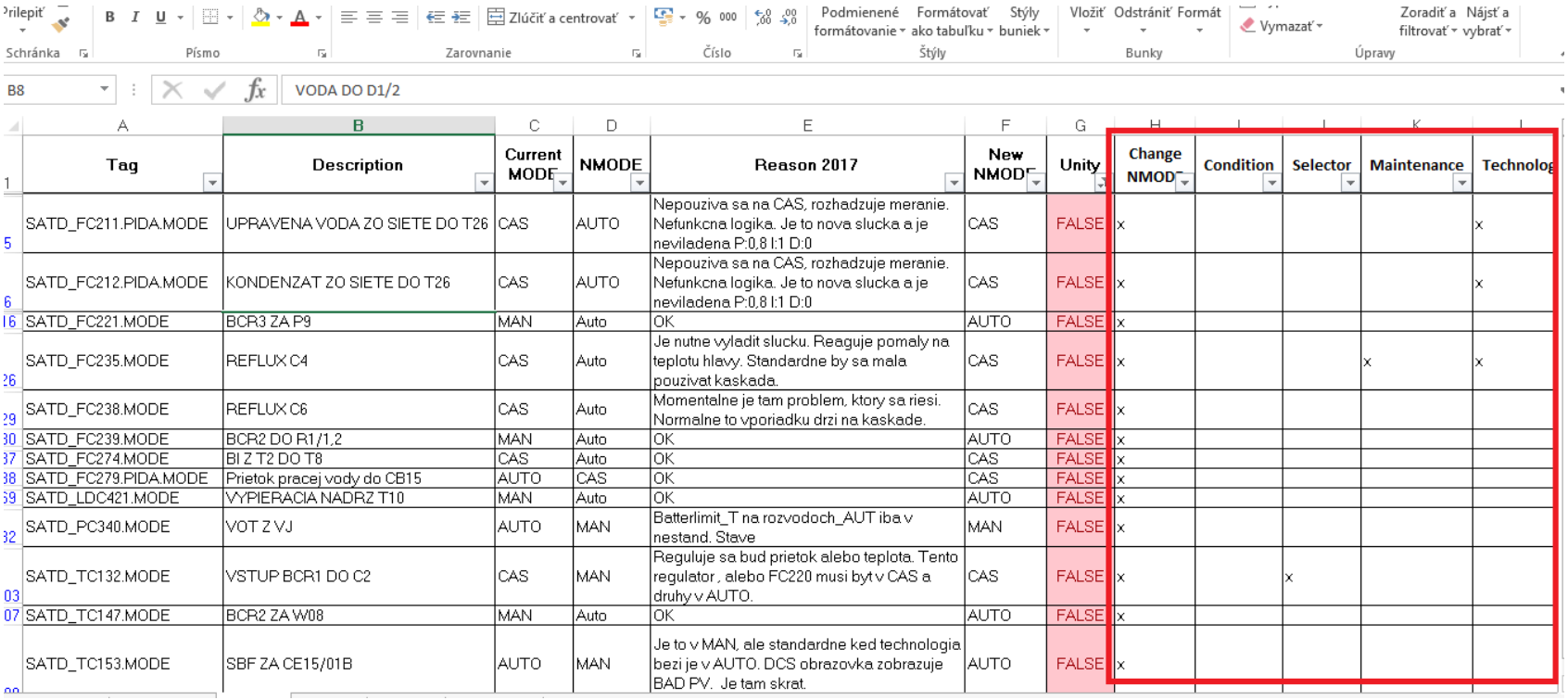
	Tag	Description	Current MODE	NMODE	Reason 2017	New NMODE	Unity	Change NMODE	Condition	Selector	Maintenance	Technolog
5	SATD_FC211.PIDA.MODE	UPRAVENA VODA ZO SIETE DO T26	CAS	AUTO		CAS	FALSE					
6	SATD_FC212.PIDA.MODE	KONDENZAT ZO SIETE DO T26	CAS	AUTO		CAS	FALSE					
16	SATD_FC221.MODE	BCR3 ZA P9	MAN	Auto		AUTO	FALSE					
26	SATD_FC235.MODE	REFLUX C4	CAS	Auto		CAS	FALSE					
29	SATD_FC238.MODE	REFLUX C6	CAS	Auto		CAS	FALSE					
30	SATD_FC239.MODE	BCR2 DO R1/1,2	MAN	Auto		AUTO	FALSE					
37	SATD_FC274.MODE	BI Z T2 DO T8	CAS	Auto		CAS	FALSE					
38	SATD_FC279.PIDA.MODE	Prietok pracej vody do CB15	AUTO	CAS		CAS	FALSE					
69	SATD_LDC421.MODE	VYPIERACIA NADRZ T10	MAN	Auto		AUTO	FALSE					
82	SATD_PC340.MODE	VOT Z VJ	AUTO	MAN		MAN	FALSE					
103	SATD_TC132.MODE	VSTUP BCR1 DO C2	CAS	MAN		CAS	FALSE					
107	SATD_TC147.MODE	BCR2 ZA W08	MAN	Auto		AUTO	FALSE					
108	SATD_TC153.MODE	SBF ZA CE15/01B	AUTO	MAN		AUTO	FALSE					
118	SATD_TC821.MODE	VZDUCH DO APEXU	MAN	Auto		AUTO	FALSE					

On-site Monitoring

- After we prepared this input report, we went to the production and discussed the problematic loops (FALSE in previous slide) with operations.

- Based on these discusions, we categorised the findings.

On-site Monitoring - Categories



Prilepiť | Schránka | Písmo | Zarovnanie | Zlúčiť a centrovať | Číslo | Podmienené formátovanie | Formátovať ako tabuľku | Štýly buniek | Štýly | Vložiť | Odstrániť | Formát | Bunky | Vymazať | Zoradiť a filtrovať | Nájsť a vybrať | Úpravy

B8 | VODA DO D1/2

	A	B	C	D	E	F	G	H	I	J	K	L
1	Tag	Description	Current MODE	NMODE	Reason 2017	New NMODE	Unity	Change NMODE	Condition	Selector	Maintenance	Technolog
5	SATD_FC211.PIDA.MODE	UPRAVENA VODA ZO SIETE DO T26	CAS	AUTO	Nepouziva sa na CAS, rozhadzuje meranie. Nefunkcna logika. Je to nova slucka a je neviladena P:0,8 I:1 D:0	CAS	FALSE	x				x
6	SATD_FC212.PIDA.MODE	KONDENZAT ZO SIETE DO T26	CAS	AUTO	Nepouziva sa na CAS, rozhadzuje meranie. Nefunkcna logika. Je to nova slucka a je neviladena P:0,8 I:1 D:0	CAS	FALSE	x				x
16	SATD_FC221.MODE	BCR3 ZA P9	MAN	Auto	OK	AUTO	FALSE	x				
26	SATD_FC235.MODE	REFLUX C4	CAS	Auto	Je nutne vyladit slucku. Reaguje pomaly na teplotu hlavy. Standardne by sa mala pouzivat kaskada.	CAS	FALSE	x			x	x
29	SATD_FC238.MODE	REFLUX C6	CAS	Auto	Momentalne je tam problem, ktory sa riesi. Normalne to vporiadku drzi na kaskade.	CAS	FALSE	x				
30	SATD_FC239.MODE	BCR2 DO R1/1,2	MAN	Auto	OK	AUTO	FALSE	x				
37	SATD_FC274.MODE	BI Z T2 DO T8	CAS	Auto	OK	CAS	FALSE	x				
38	SATD_FC279.PIDA.MODE	Prietok pracej vody do CB15	AUTO	CAS	OK	CAS	FALSE	x				
59	SATD_LDC421.MODE	VYPIERACIA NADRZ T10	MAN	Auto	OK	AUTO	FALSE	x				
32	SATD_PC340.MODE	VOT Z VJ	AUTO	MAN	Batterlimit_T na rozvodoch_AUT iba v nestand. Stave	MAN	FALSE	x				
03	SATD_TC132.MODE	VSTUP BCR1 DO C2	CAS	MAN	Reguluje sa bud prietok alebo teplota. Tento regulator , alebo FC220 musi byt v CAS a druhy v AUTO.	CAS	FALSE	x		x		
07	SATD_TC147.MODE	BCR2 ZA W08	MAN	Auto	OK	AUTO	FALSE	x				
	SATD_TC153.MODE	SBF ZA CE15/01B	AUTO	MAN	Je to v MAN, ale standardne ked technologia bezi je v AUTO. DCS obrazovka zobrazuje BAD PV. Je tam skrat.	AUTO	FALSE	x				

Resolution of the findings

- After defining the report, we created extended reports and started the second round of this activity.

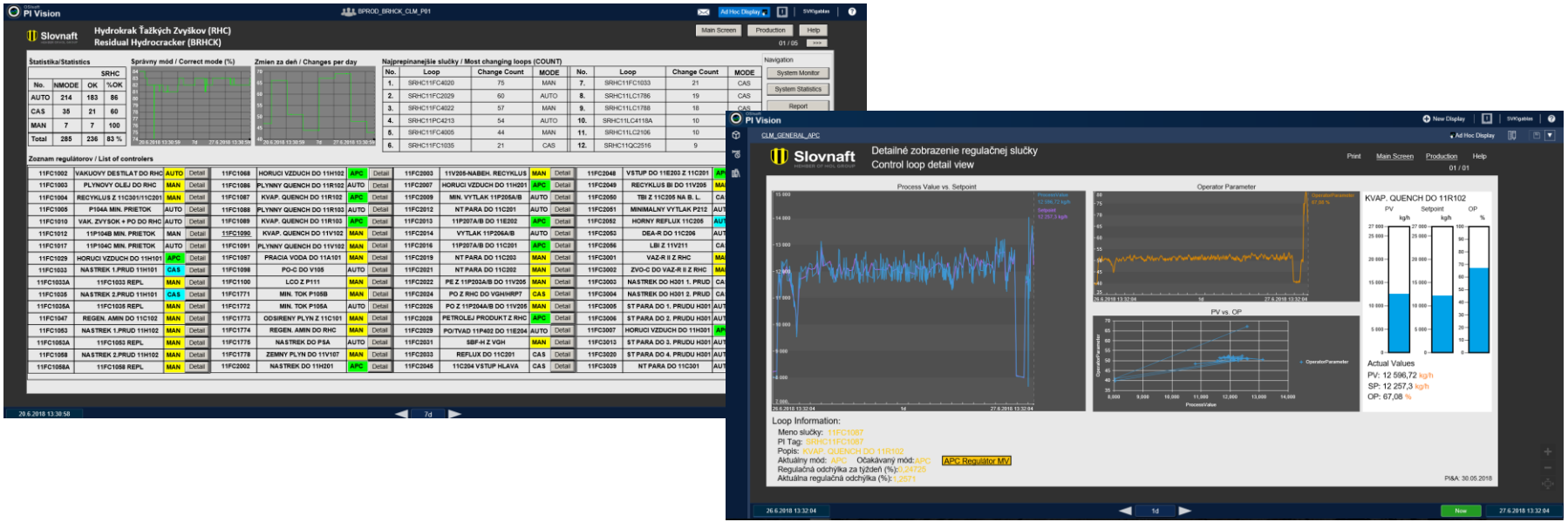
- In order to support this activity, a good online visualisation tool is necessary. We decided to use the PI System for implementation of this application.

Why the PI System has been selected?

- This system was already working in the refinery
- Good consistency of the data which we need
- We defined one source of truth
- Good development environment

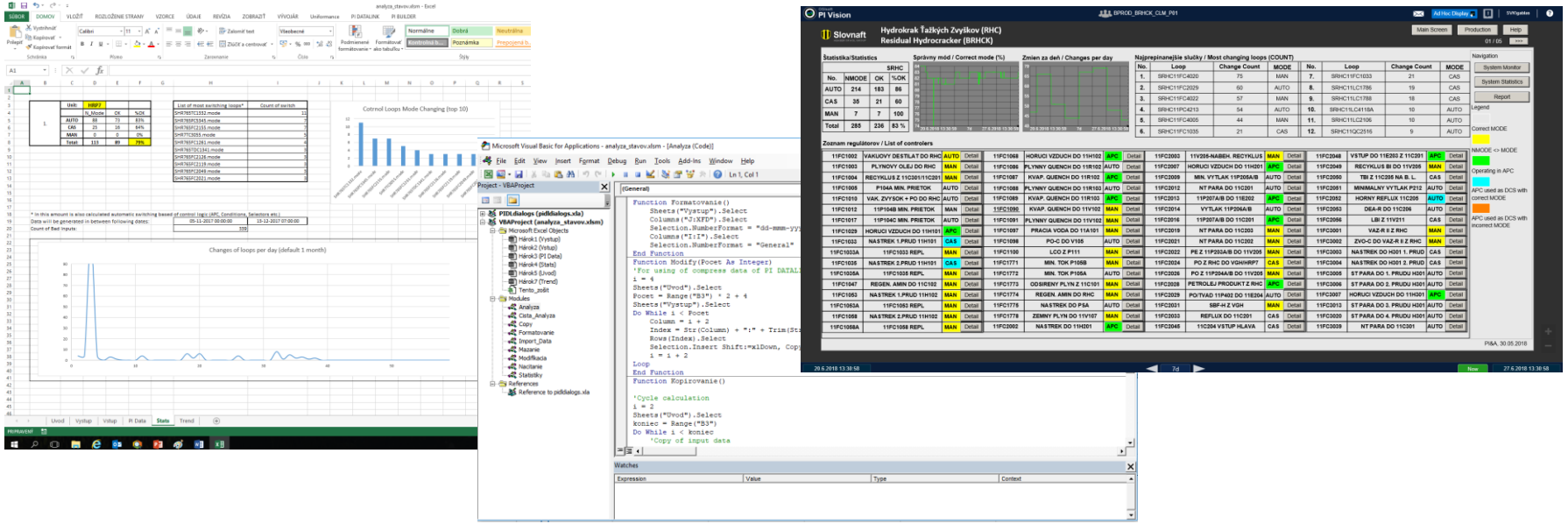
Motivation for on-line monitoring

To create a tool for visibility of control related problems: operational, instrumentation, tuning etc.



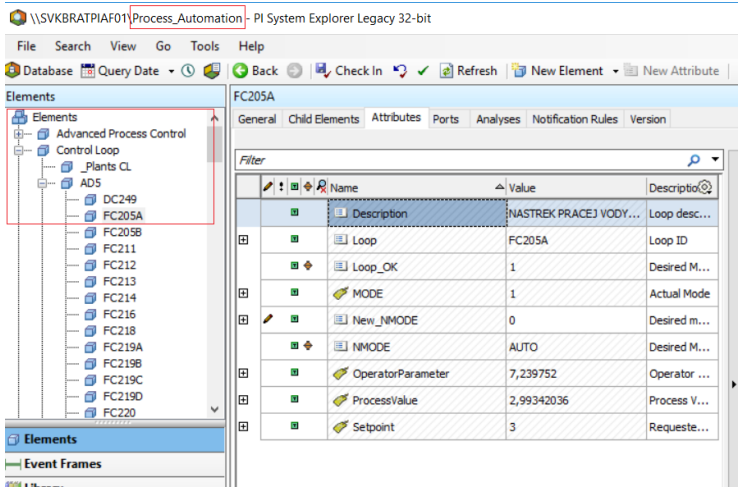
Motivation for on-line monitoring

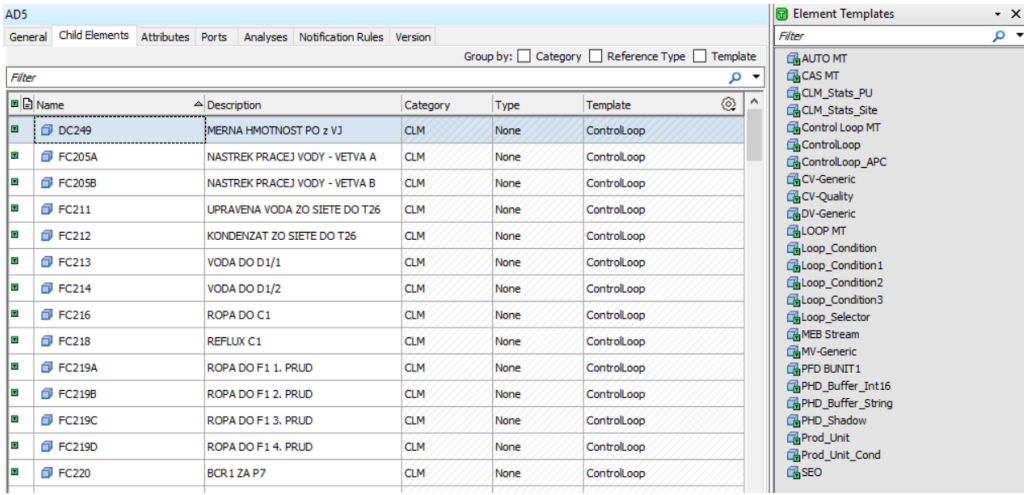
But... previous slide is the actual implemented solution and there was a very long path to come to this point.



Why we used PI AF?

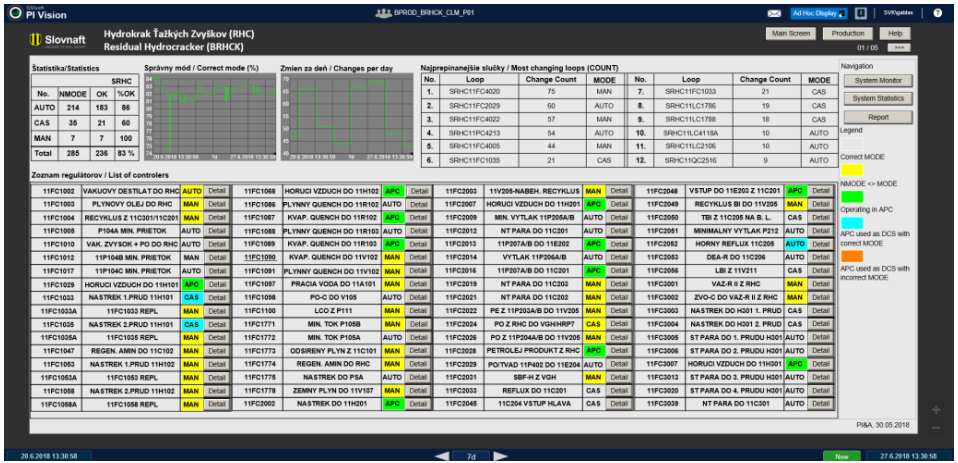
- To define good structure of data (PI System Explorer)
  - Database\Application\Unit (T)\Loop (T)
- For using of specific calculations (conditions / selectors / APC)

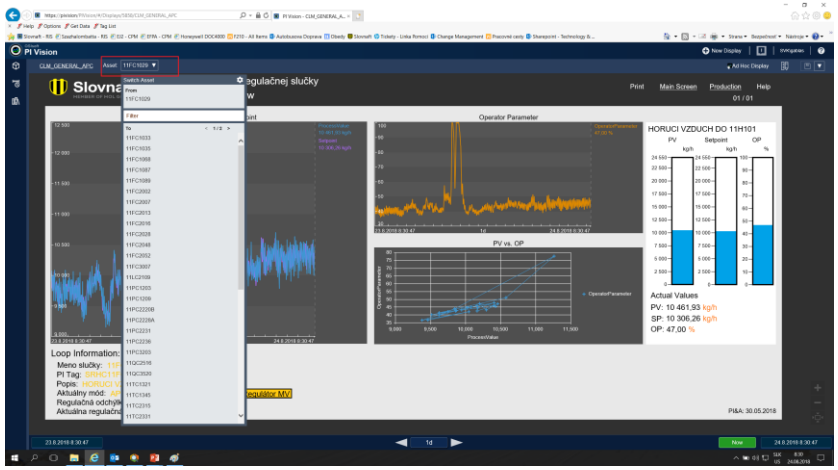




Why we used PI AF?

- As all necesary data are based on the templates we can simply generate dashboards.
- Detail displays are “Element / Asset Relative” – only one display for all loops from selected template.





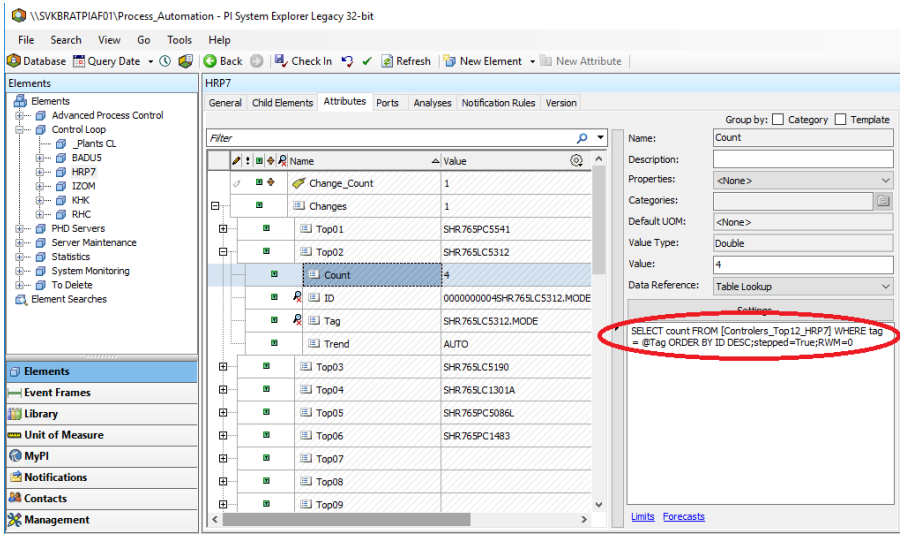
PI as a tool for implementation of CLPM

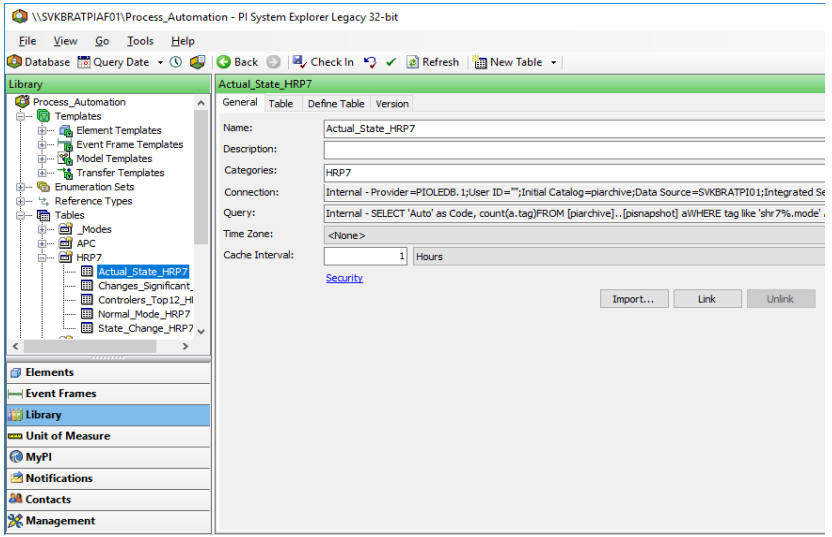
For the implementation of Control Loop Performance Management (CLPM) – Loop Monitoring application, we used the following tools:

- In the first step MS Excel and VBA – PI DataLink
- PI AF Server (for connection we are using PI System Explorer)
- PI OLEDB (which is executing the logic implemented in SQL)
- PI ProcessBook / PI Vision
- MS PowerShell

Development of the SQL Application

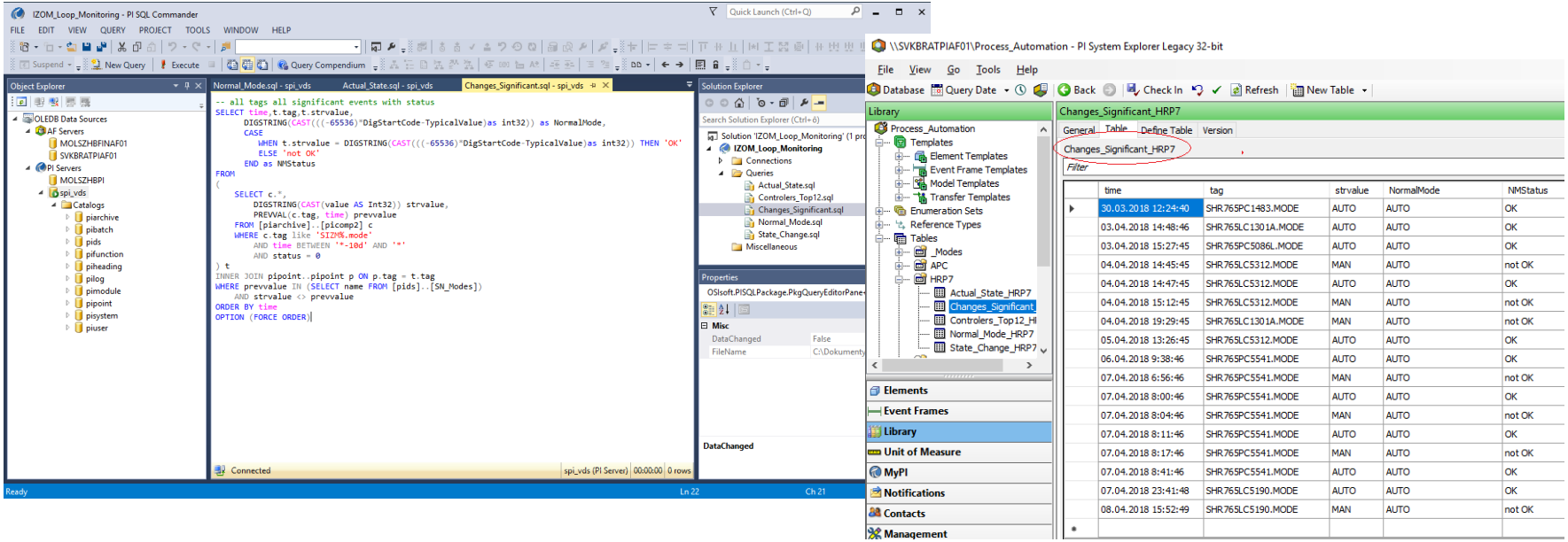
For generation of dashboard data (list of loops etc.) we used SQL Tables connected to PI System via PI OLEDB interface.





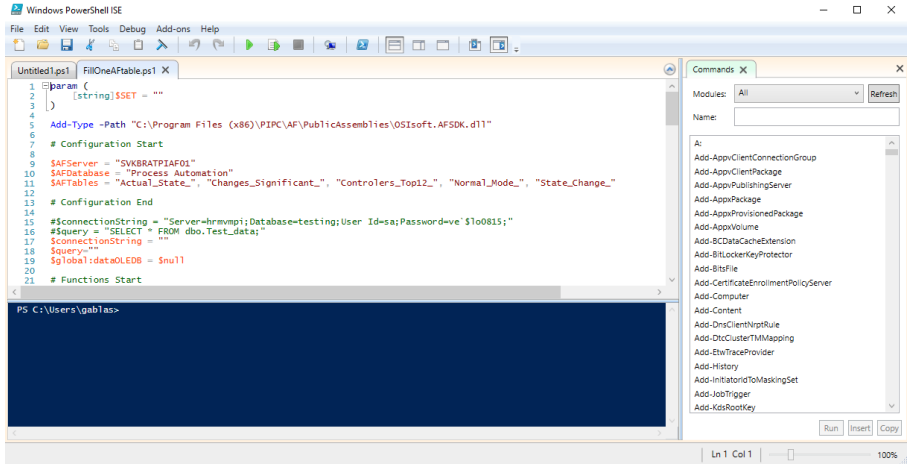
PI OLEDB Enterprise

PI AF Tables contain SQL scripts which have been generated and debuged in PI SQL Commander.



Automatic Refresh

We developed application for some production units as a pilot using Import Tables. Import Table cannot be set to reload data in PI System Explorer automatically. For this, we used MS PowerShell script using PI AF SDK at first.



Automatic Refresh

This script is being executed during the night and it takes about 12 minutes (for 8 production units). This is big difference in comparison to the old excel tool (developed in VBA) which took a couple of hours for same amount of loops. This script is executed on the server as a scheduled task.

Pros vs. Cons

- Pros

- Fast response
- Data availability for all users
- Possible modifications of screens (Ad Hoc displays)
- Template based solution
- Possible to generate reports and export them to *.csv or *.xml, from predefined screens

- Cons

- Many different tools have to be used
- Longer time for development and debugging
- No automatic updates of the tables (has to be started from external environment)

Implementation of findings

- Complete the implementation reports in cooperation with other departments
  - analysis of problems for non-desired modes
  - solution proposal of the first step
  - definition of criteria for individual solution

- Initialisation of assignment of a new MOC (Corrective Action) and operative orders based on common rules

Findings (Types of corrective actions)

- NewNMODE (change NMODE)
- Maintenance (trouble with instrumentation or other HW components)
- Conditions (setting and agreeing conditions for correct statistics for LM) – implemented as a calculation in PI System Explorer
- Selection (setting and agreeing selectors for correct statistics for LM) – implemented as a calculation in PI System Explorer
- Technology (the changes in the technology process)
- Cancellation (cancellation of the control loop or some of its elements)

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CONTROL LOOP MONITORING AND PERFORMANCE MANAGEMENT

CHALLENGE

Is to increase the level of automation on the production with a monitoring of desired mode of control loops, based on which we want to define corrective actions.

- For online monitoring we can decrease the time to make data available
- With using other solution we consume a lot of time.

SOLUTION

Integration of PI Tools (PI AF, PI OLEDB, PI Vision) in to one logical part which can provide in a user friendly way fast access to requested data.

- This was a cooperation between local IT and Process Information and Automation departnemnts.
- To be aligned, we had to split the work tasks between Automation and IT.

RESULTS

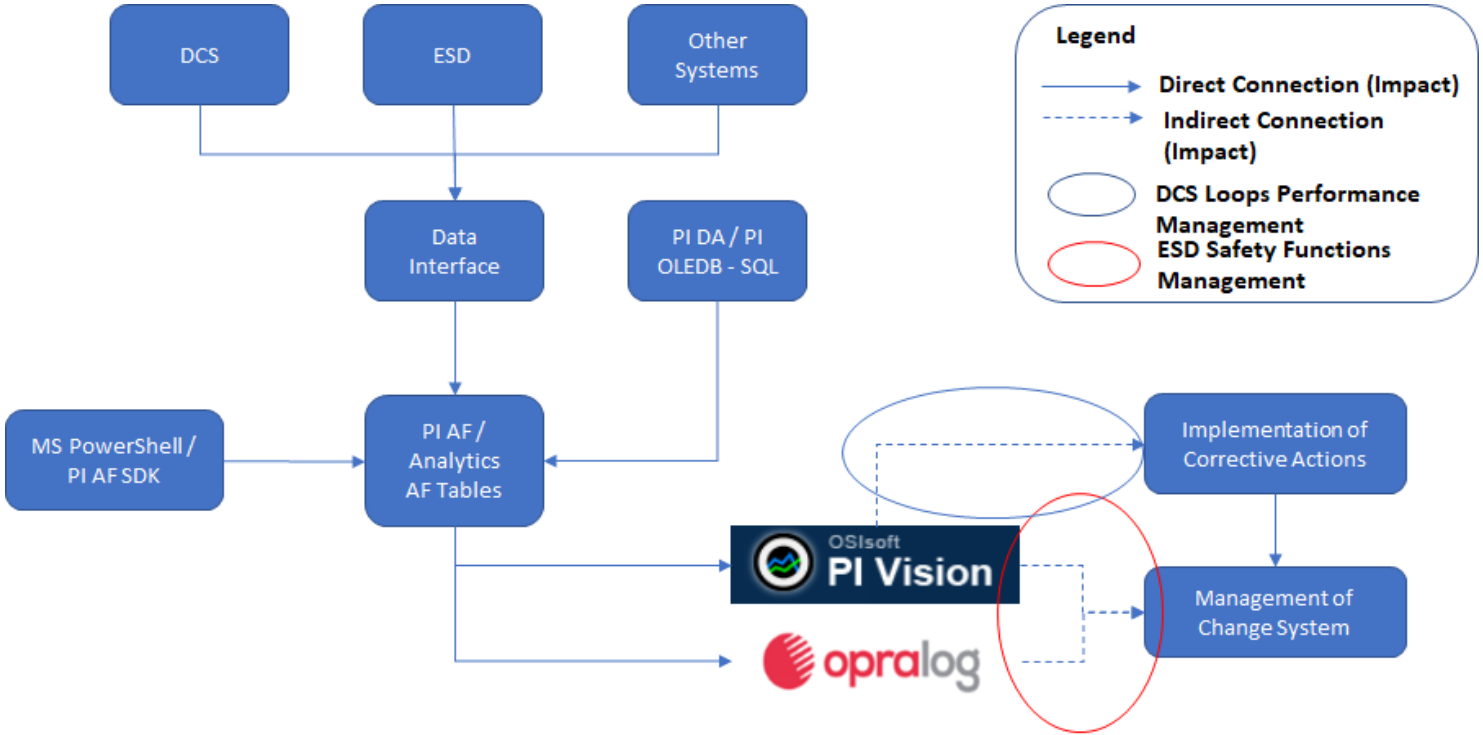
An application which we can use to increase level of automation by identifiing problems in production.

- The tool make data available in few seconds instead of hours.
- The tool should be used by production for checking the production status.

Next steps...

- Integration with whole Refinery Information System,
- Add monitoring and management of ESD functions based on IEC 61511,
- Add calculation of statistics and control quality,
- Development of full **I**nformation **S**ystem of **C**ontrol **S**ystem with monitoring of Network, ESD and DCS, Loops, Safety Functions etc.

Next steps... (ISCS)



Speaker

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- Senior Control Engineer
- SLOVNAFT, a.s.
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Questions?

Please wait for the **microphone**

State your **name & company**

Please remember to…

Complete the online survey for this session