

PCN STANDARD IMAGE (PSI) IMPLEMENTATION

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Abstract

Chevron IndoAsia Business Unit (IBU) PCN (Process Control Network) team supports more than 150 PCN/SCADA Systems with vast coverage area, across the IBU, including 3 Operating Units (OU): Sumatera, Kalimantan and Geothermal Operation (GPO). Some of those PCN Systems are required connection to business network while others are air-gapped. By having that condition and number of existing workforces, we cannot apply patches and anti-virus update in timely manner; conduct IP (Information Protection) evergreen processes as requested, etc. We initiated a project to standardize PCN system, including hardware & software, with the main objectives to have a better evergreen processes and reliable support for business continuity. This project will maintain HMI (Human Machine Interface) and Controller Applications also operation and maintenance process in as is condition. IBU is the first business unit which implemented PCN Standard Image. Implementation standard image for PCN has unique challenges especially related with variety of HMI brands and technology in our production facilities. Based on our assessment of current IBU PCN System population, for the first stage, this project will focus on Wonderware InTouch-based HMI as the highest number of system and most doable target. The population represents 45% IBU system (40% IBU computers). Beside that we developed also compliance dashboard to measure compliance performance.

Keywords for this abstract:*

PCN, Standard, Image, Compliance, Dashboard, Performance

1. Introduction

There are 157 PCN/SCADA systems in Sumatera, East Kalimantan, and GPO operating units that must be supported / maintained by IBU IT PCN team and maintenance teams. Segregation area between IT PCN team and maintenance teams can be described by the following PCN architecture diagram (Fig. 1). So maintenance teams are responsible to support PCN systems in respective areas while IT PCN team must support all PCN systems.

One of the roles and responsibilities of IT PCN is to manage and to lead the implementation of CIRS (Chevron Information Risk Standards) Policy and Technical Control for all PCN applications and infrastructures by monitoring IP compliancy status, ensuring completeness and current of PCN inventory database, facilitating PCN Audit process and manage gap remediation processes, etc.

According to the above roles and responsibilities, IT PCN must ensure these PCN systems comply with CIRS policy and technical control for PCN application and infrastructure. IT PCN must run compliance evergreen processes for all PCN systems.

Unfortunately in 2008, IBU PCN facilities was audited by corporate auditors and the result is Less Than Satisfactory (LTS). This result is the lowest qualification.

PCN Architecture Diagram

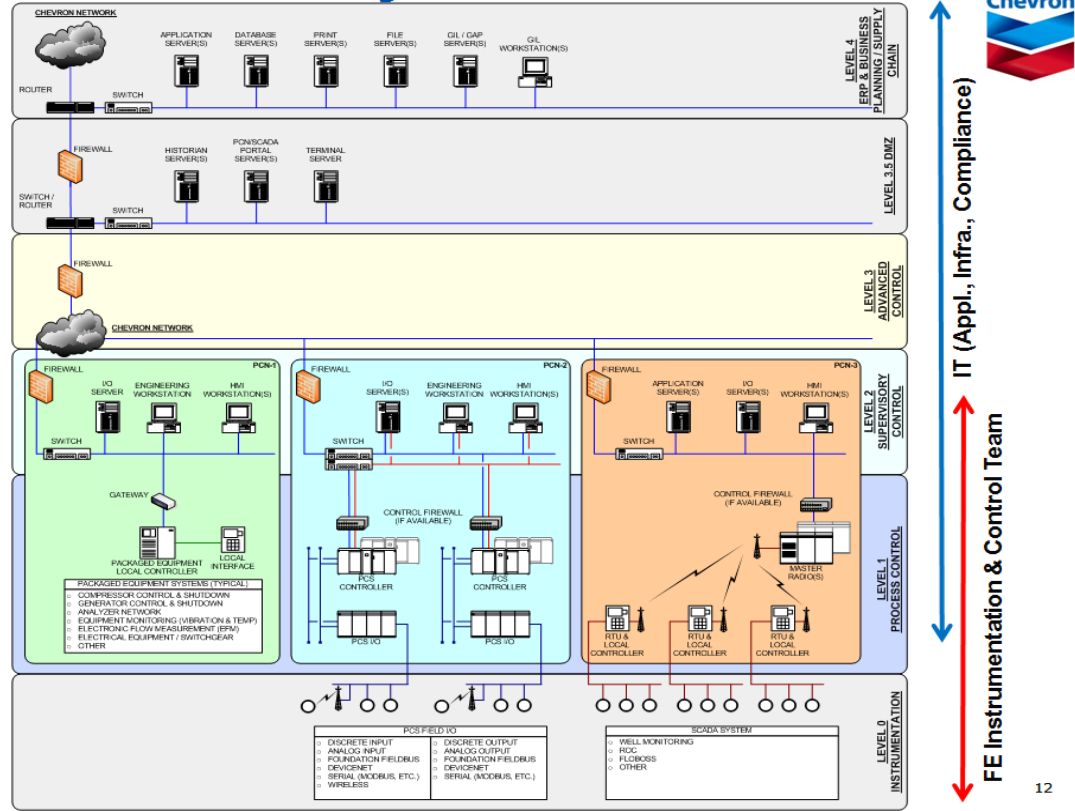


Fig. 1: PCN Architecture Diagram

Most of audit findings indicate that PCN compliance evergreen processes was not conducted in a good manner. Base on this result, IT PCN conducted brainstorming to find out the causes by using fishbone analysis as mentioned by the following fishbone diagram (Fig. 2).

Machine

1. Various HMI brands/applications
2. Various HMI versions
3. Various O/S versions
We used various O/S, starting from DOS until Window XP. Various backup and restore tool
4. Various and aging HMI PC specification
5. Aging hardware and software

Method

1. Site visit
We have to visit PCN system facilities one by one to comply these systems.
2. Done manually
HMI PC is complied manually, started from O/S, checked default ID and password, reviewed IDs to ensure authorized personnel only that have access to the system, etc.
3. Data of compliance status, evergreen activity, and other data are kept in spreadsheet that cannot be shared and analyzed easily.
4. No compliance governance
Any new PCN system can be put in service without compliance commissioning first. Lack coordination among, engineering teams, maintenance teams, and IT PCN team.

- No clear job priority
No clear priority in resource allocation among compliance evergreen, PCN operation support, and PCN project support.

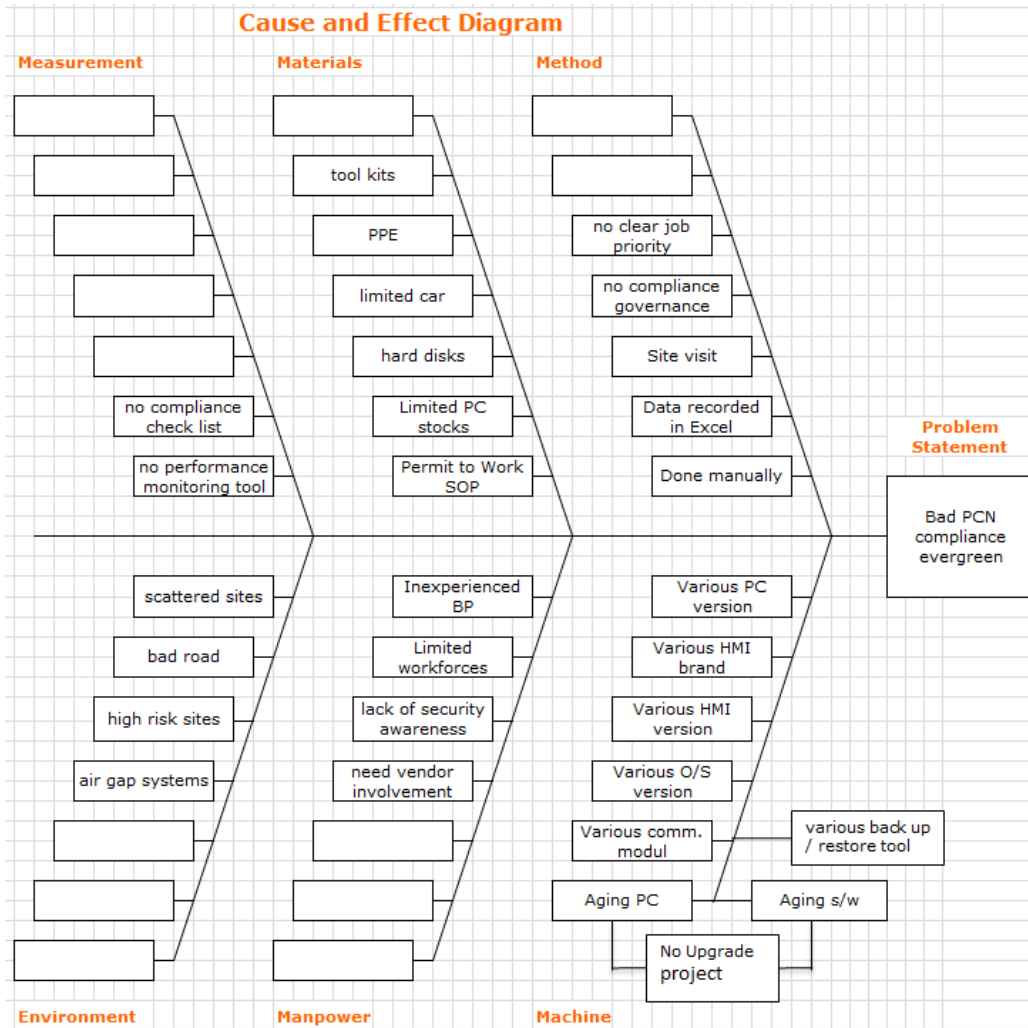


Fig. 2: Fishbone Analysis

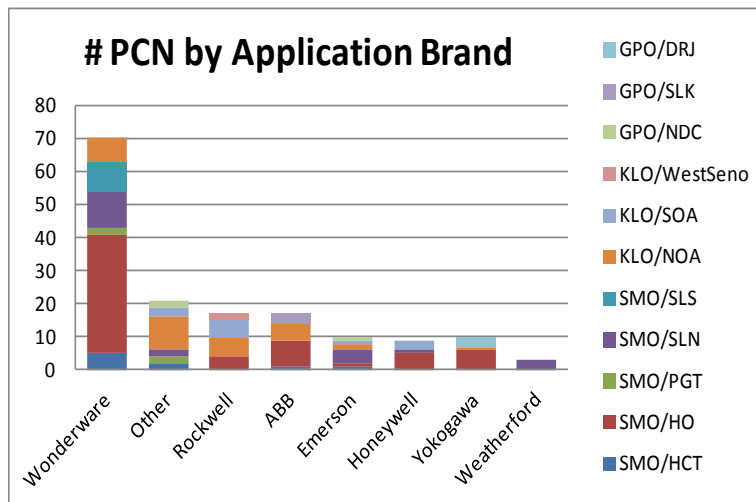


Fig. 3: HMI Brand population

Material

1. Permit to work (PTW) SOP
2. Limited PC stock
We need to stock PC with different specification.
3. Hard disk
Backup and restore image are conducted to and from external hard disk
4. Limited car
Car is needed to drive evergreen personnel to PCN site.
5. PPE (Personal Protected Equipment)
All evergreen personnel who visit PCN facilities must use proper PPE.
6. Tool kits
Tool kits are really needed in conducting compliance evergreen activities.

Manpower

1. Limited workforce
Personnel that allocated in evergreen activities are limited; consist of permanent employees and business partners
2. Inexperience business partners
Business partner contract is usually renewal every 3 years in line with their contract expiration. So we have to refresh their knowledge and experience in conducting compliance evergreen activities
3. Lack of PCN security awareness
Operator, maintenance team, facility owner and other PCN stakeholders need to improve their awareness on PCN security.
4. Need vendor (SME) involvement
For some HMI brand and version, involvement from vendor as SME of the software is very important in complying the PCN system.

Environment

1. PCN systems are scattered
2. Bad road
Some of roads to PCN sites are in bad condition especially in rain session.
3. PCN sites are high risk places
4. Most of PCN systems are air gap system. The systems are not connected to a business network to be monitored remotely.

Measurement

1. No performance monitoring tool
We cannot measure progress of compliance evergreen activities
2. No compliance check list
Compliant activities just base on experiences and tidiness of evergreen personnel.

We have identified the significant impacts on quickness and accuracy of evergreen processes is machine and method aspects. To address the above obstacles, we have developed stage 1 initiative that focus on PCN systems that use Wonderware as HMI brand. We have defined opportunities in stage 1 initiative as follow:

1. Upgrade and standardize HMI version.

2. Upgrade and standardize Window O/S
3. Upgrade and standardize HMI PC
4. Set up PCN network configuration to make the PCN systems can be monitored remotely and securely.
5. Deploy IT solution to speed up and simplify compliant evergreen processes.
6. Develop IT application system or a ool to manage compliant data and compliant performance measurement.

2. Solution Definition

Business Case

Initially, there are two filed exceptions that related with the antivirus update and the vendor supported version & patches of software & operating system. In the future, the project wants to remediate these exceptions. For the IP compliance & patches testing processes, because currently there is no test environment that can represent PCN computers installed on the field, so the testing processes cannot be done. In the future, by using standard image, the PCN computers installed on the field can be representing by testing environment, so the IP compliance and patches updates can be tested prior installation on the PCN computers installed on the field. Because of unavailability of the test environment as well as the tools that can help the custodian on executing IP compliance evergreen processes, currently the custodian cannot follow IP compliance evergreen expected schedule. In the future, the project wants to provide tools to simplify the compliance processes and documenting the level of compliance status on each PCN computers installed. Aging computer hardware and many OS variation are currently in use. By the project, computer hardware will be renewed and standard OS & application image will be used. So the gap analysis can be illustrated by the following figure 4.

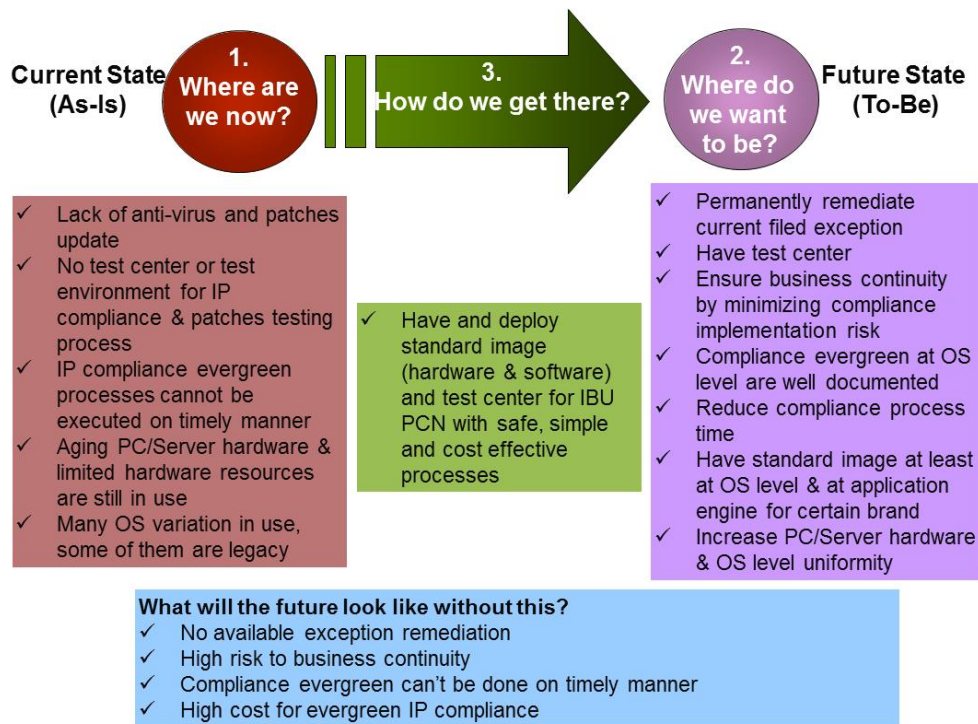


Fig. 4: Gap Analysis

Developing and Selecting Alternative Solution

Alternative Generation

- ❖ Do Nothing
 - As-Is processes. Replace broken hardware using existing hardware spare.
- ❖ Alternative 0: Replace Broken Hardware
 - Purchase new hardware for hardware spare
 - Replace broken hardware with the new hardware spare
- ❖ Alternative 1: Basic Package
 - Replace existing hardware with the new hardware
 - Upgrade operating system and application version
 - Provide Windows compliance template, malware protection, and backup/restore utility
- ❖ Alternative 2: PSI Package
 - Basic package, bundled in standard image
 - Integrated domain authentication, remote access utility and inventory system
 - Log review management, compliance, patches & malware protection update management.
- ❖ Alternative 3: PSI & Test Center Package
 - PSI package plus test and support center facility
 - Life cycle management, change management, test and support center management

Selection Criteria

Selection criteria have been developed as showed up by the following table.

Criteria	Weight	Description	Score Criteria
Availability	30%	Based on common CIA (Confidentiality, Integrity, Availability) analysis, availability is the top priorities for PCN	(5) Potential increase PCN Computer availability (3) Maintain current PCN Computer availability (1) Possible reduce PCN Computer availability
Maintainability	25%	<ul style="list-style-type: none"> • PCN location are spread and on the field • Limited resource available to support PCN maintenance • Low effort on setting up PCN computer will increase its availability 	(5) Low effort on setting up PCN Computer (3) Moderate effort on setting up PCN Computer (1) High effort on setting up PCN Computer
IP Compliance Evergreen	25%	<ul style="list-style-type: none"> • PCN location are spread and on the field • Limited resource available to support PCN IP evergreen • More automatic task will increase IP compliance consistency across PCN 	(5) Limited manual task (3) Some manual task (1) Manual task for all
Strategic Alignment	10%	No PCN standard image available in corporate	(5) To be Chevron wide standard and test center (3) IBU standard (1) No standardization
Do-ability	10%	Possibility to be developed by IBU	(5) Using full IBU local resource (3) IBU local resource with some

			guidance from ETC (1) IBU local resource with TSA from ETC
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Table 1: Selection Criteria

Alternative Selection

The result of evaluating each alternative solution base on the above selection criteria is presented by the following table

Alternatives	Availability (30%)	Maintainability (25%)	IP Compliance Evergreen (25%)	Strategic Alignment (10%)	Doability (10%)
Alternative 3: PSI & Test Center Package	Potential increase PCN Computer availability (5)	Limited effort on setting up PCN Computer (5)	Limited manual task (5)	To be Chevron wide standard and test center (5)	Using full IBU local resource (5)
Alternative 2: PSI Package	Maintain current PCN Computer availability (3)	Moderate effort on setting up PCN Computer (3)	Some manual task (3)	IBU standard (3)	IBU local resource with some guidance from ETC (3)
Alternative 1: Basic Package	Possible reduce PCN Computer availability (1)	High effort on setting up PCN Computer (1)	Manual task for all (1)	No standardization (1)	IBU local resource with TSA from ETC (1)
Alternative 0: Replace Broken Hardware					
Do Nothing					

Table 2: Selection Process

Alternatives	Availability 30%	Maintainability 25%	IP Compliance Evergreen 25%	Strategic Alignment 10%	Doability 10%	Score
Alternative 3	5	5	5	5	1	4.6
Alternative 2	4	5	5	3	3	4.3
Alternative 1	3	3	3	3	3	3
Alternative 0	3	1	1	1	5	2
Do Nothing	1	1	1	1	5	1.4

Table 3: Selection Scoring

Based on assessment, alternative 3 get the highest score:

- By having PSI & test center, it potentially increase PCN computer availability due to standard image used (minimize “silly” problem) and all patches will be tested prior deployment
- By using standard image (PSI), setting up PCN computer will be simplified (using tool) and will have limited manual human touch
- PSI & test center will provide backup & recovery tool, integrated inventory tool, compliance management tool, patches update management tool, malware protection update management and log review tool

- PSI & test center is an opportunity for being Chevron wide standard, but it will need corporate involvement to ensure the solution architecture align with the corporate needs

Base on the above scoring, project team recommend selecting alternative 3 as the solution. Based on the selected alternative, the business scope of the project are:

- **Standard Image consists** of PCN standard image development & deployment, new desktop hardware & bigger LCD monitor, new operating system, latest version of HMI software, desktop hardware compatible PLC connection device, latest version of IO/OPC server, as-is required software (e.g. PLC programming software, MS Office), OS compliance (Windows CIRS technical control), standard malware protection and standard backup & recovery tool & process
- **Backend Infrastructure** consists of integrated domain authentication, remote access utility for maintenance, inventory system, compliance management, patches update management, malware protection update management and log review management
- **Test Center** consists of test environment completed with sample PLC and IO panel, room or facility, test center operations management, integrated change management and life cycle management

While PCN operations, PLC hardware & program, HMI program, operations and engineering will be kept as existing operations and functions.

Test Center

The purpose of PSI test center is for supporting PSI evergreen testing, change management and life cycle. This purpose can be categorized as follows:

- PSI life cycle management:
 - Test center will have responsibility and process to define and support PSI versioning (regular update and minor versioning)
 - Test center will have ability to develop minor version update image
- Change management:
 - Test center will govern all process for deploying update to PSI, including patches, CIRS compliance, malware protection & PSI minor versioning update
 - Test center will have responsibility to provide update implementation preparation check list (PPC) and provide update implementation procedure/check list
- Test Center management:
 - Primary Test Center function is to test the patches and certify all update on PSI. The high level process of monthly Microsoft patches testing & deployment is shown on below process flow (Fig. 6)
 - Result will be published using SharePoint Portal. For N/A patches will also be published on SharePoint.
 - For compliance update:
 - Test required for the update
 - Deploy using package similar with patches update
 - For antivirus definition update:
 - No test required for definition update
 - Deploy using manual schedule (based on each PCN process & criticality)

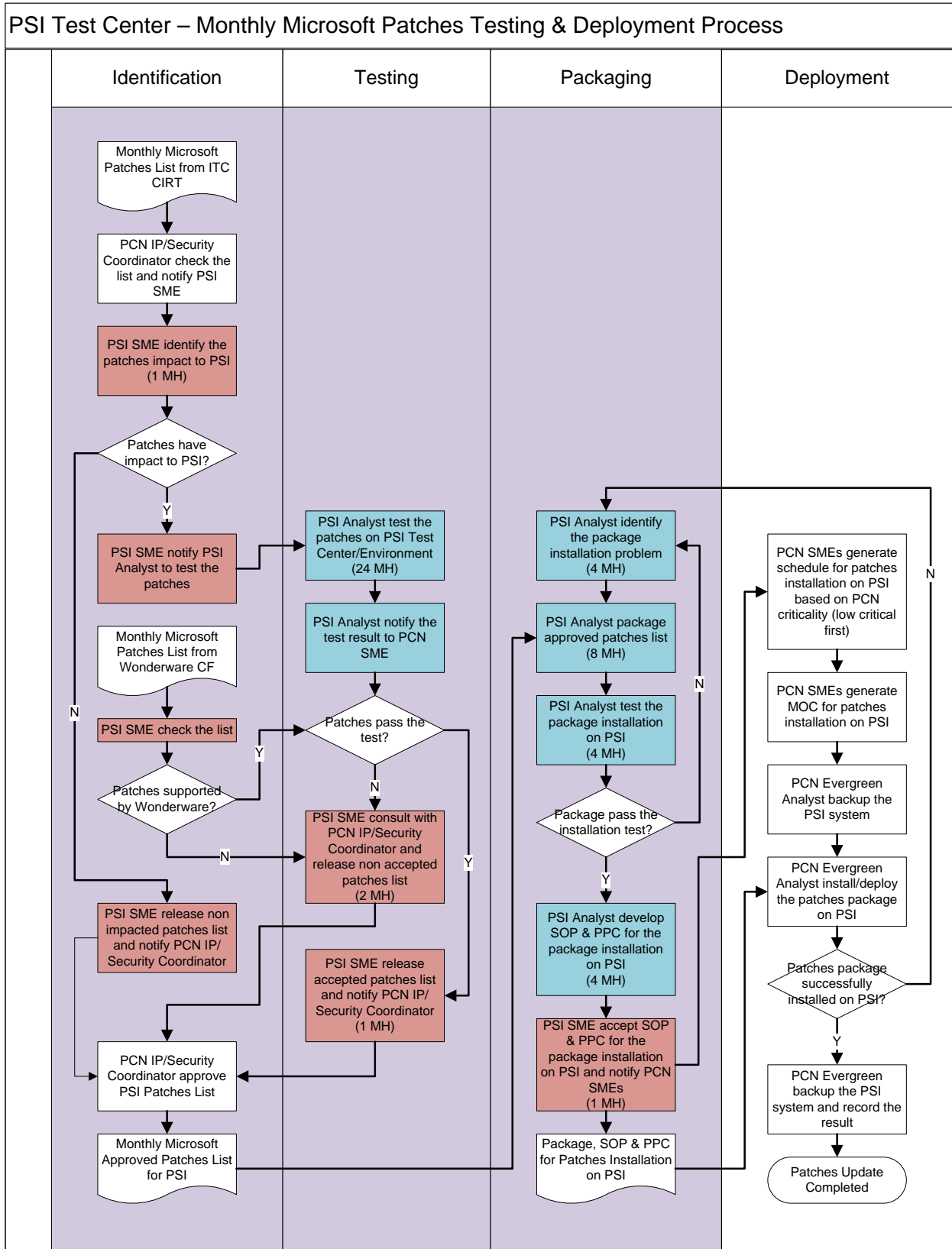


Table 4: Test Center Flow Chart

Project Deliverables

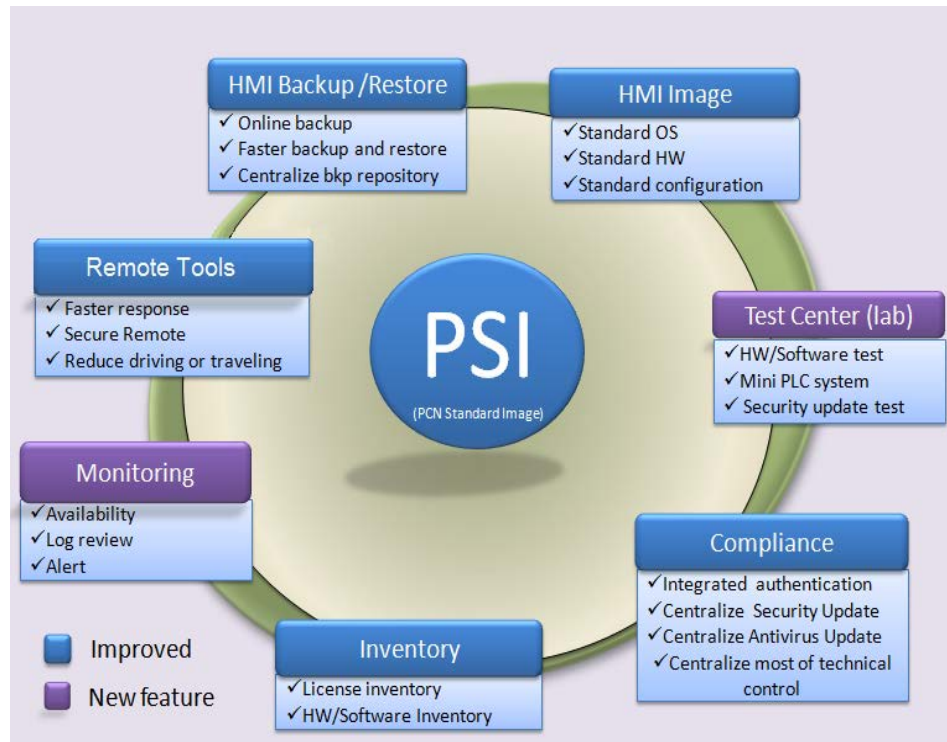


Fig. 5: PSI Technology Overview

Benefits from the project result are

1. HMI Image
 - All O/S have been standardized by using Microsoft Window 7
 - HMI PCs have been upgraded
 - All Wonderware versions have been upgraded and standardized to Wonderware InTouch 10.5
2. Test Center
 - Any change that will be installed in PCN system (production environment) must be tested first at test lab to ensure that changes will run smoothly including update antivirus and patches.
3. Compliance
 - By using Microsoft SCCM, compliance evergreen can be done remotely in timely manner including anti-virus update, new patches installation, and other technical controls.
4. Inventory
 - By using Microsoft SCOM, inventory of software, license, and hardware can be done automatically.
5. Monitoring
 - By having capability to monitor status of a PCN system, we can detect availability of PCN system immediately. So availability of PCN systems can be improved significantly from 78% to 96% (17%).
6. Remote tools
 - This feature can help a lot in reducing mileage of our personnel in compliance of the PCN systems by 10.383 km per year (onshore and off shore).
7. HMI backup/restore
 - Backup and restore can be run remotely and automatically by setting scheduler jobs.

- Cost avoidance that resulted from the project is US \$ 162.800 / yr. plus saving 12 FTE (Full Time Employees) that might be recruited to do PCN compliance in timely manner.

Infrastructure architecture is designed as follow

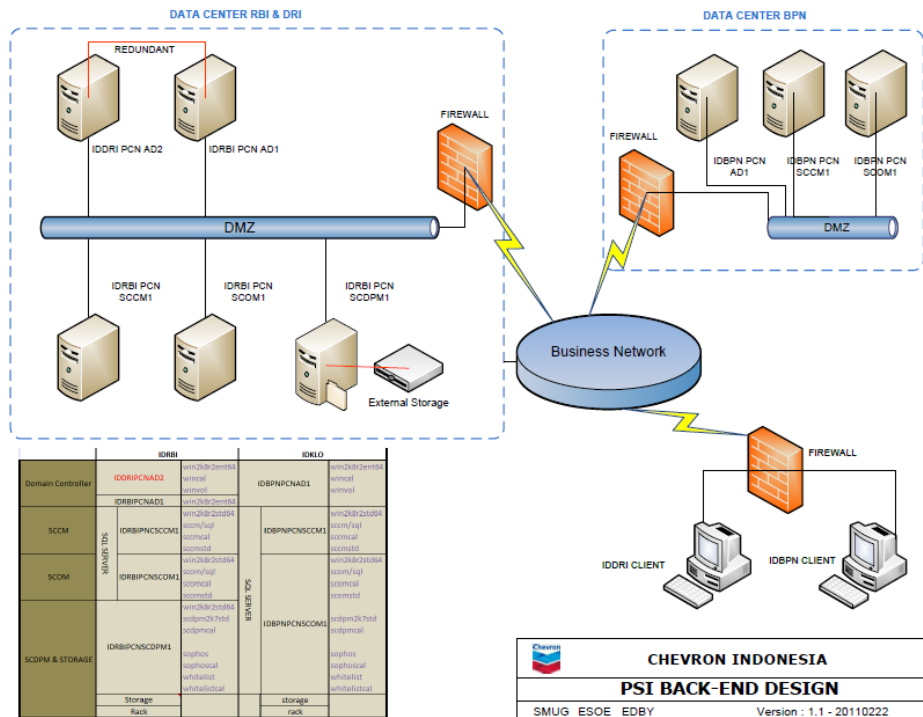


Fig. 6: Infrastructure architecture

3. Compliance Database and Performance Dashboard

As mentioned by Performance Prism framework, we started with stakeholder satisfaction. In this case we have identified that the needs of our stakeholders are

- PCN systems comply with CIRS (Chevron Information Risk Standards) Policy and Technical Control for all PCN applications and infrastructures.
- Compliance evergreen can be run in timely manner.

We have grouped all evergreen activities into 4 groups as follow

- PCN facilities compliance (6 performance variables and 45 attributes).
Operation teams as facility owner are responsible to ensure that their control room or other PCN facilities comply with all regulation pertinent to the facilities:
 - Physical security or access control
 - Log book to record visitors to the facility including his/her purpose. The log book must be reviewed by operator regularly.
 - Sticker and banner to state that the facility for authorized person only and the equipment can be operated by the assignee only
 - Appliances/environmental control such as smoke detector and fire extinguisher availability, fire extinguisher inspection, air conditioning, etc.
 - Backup power or UPS availability
 - Others such as housekeeping, operator shift schedule, emergency lighting, etc.
- Controller compliance (6 performance variables and 38 attributes)
Maintenance teams are responsible to ensure their controllers' compliance

- Physical security of controller cabinets
 - Modification control such as MOC (Management of Change), controller program backup before and after changes, etc.
 - Backup power availability
 - Spare parts and error reports.
 - Backup and engineering NB such as P&ID document and manual document availability, redundancy system availability, etc.
 - Document and Housekeeping
3. System compliance (7 performance variables and 48 attributes)
Facility owner, maintenance team, and IT PCN are responsible for this subject because all the team must collaborate to accomplish the subject such as
- inventory
 - Risk assessment and CIA+E (Environmental) assessment.
 - Disaster recovery plan,
 - Disaster Recovery Test especially if the category of the PC system is mission critical or significant.
 - Network diagram availability and accuracy
 - User ID management
 - Other.
4. Computing compliance (8 performance variables and 56 attributes)
IT PCN is responsible to comply all HMI PCs at all sites:
- Inventory of HMI PCs and servers
 - Backup image must be done regularly or before and after changing on the image or HMI applications. IT PCN must ensure also that the backup result can be restored properly.
 - Event log must be kept well to make easier in troubleshooting if something wrong happen on the PCN system.
 - User ID must be reviewed regularly and its password must follow password management rules.
 - Operating system must follow technical control rules.
5. PCN network compliance (7 performance variables and 44 attributes)
- Physical security of network panel and its inventory
 - Vowancy and template
 - ACL (Access Control List)
 - Admin ID and TACACS (Terminal Access Controller Access-Control System) pertinent to remote authentication management
 - Log review and Qradar
 - NST (Network Security Toolkit) registry
 - IOS version

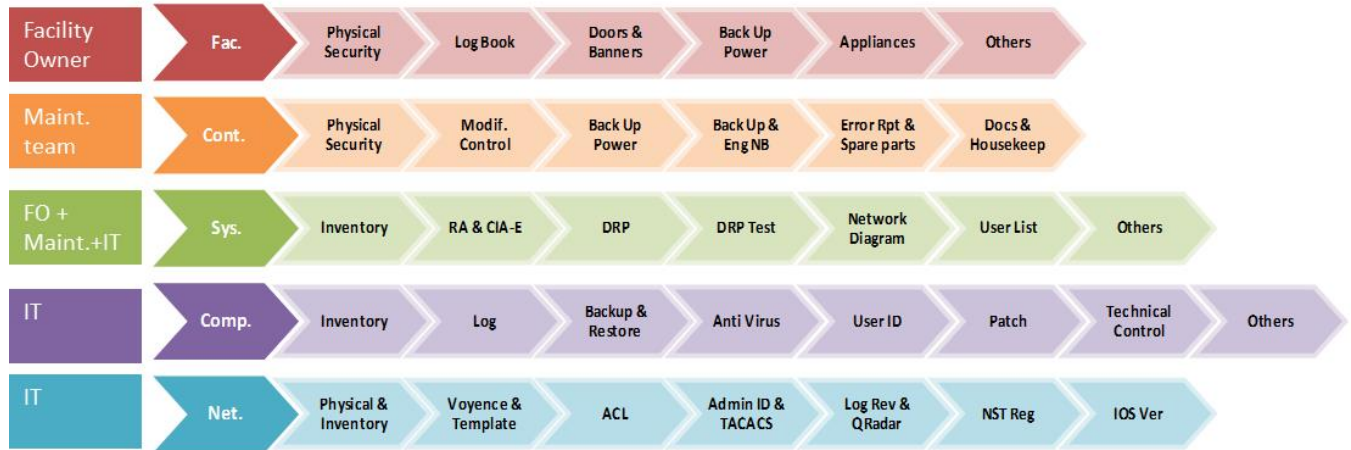


Fig. 7: Variable Performance of PCN compliance

The following forms are example forms of PCN facility performance variables and its attributes (Fig. 8 and Fig. 9). This form must be filled and updated by operator or facility owner of the PCN facility to ensure the data is up-to-date. Once all the attributes completed, the form will calculate automatically the score in percentage of facility compliance. Similar forms have been developed and implemented for controller, system, computing, and network subjects. We are using Microsoft SharePoint as platform of this compliance application.

PCN Facility Inventory - Darajat Control Room	
Location Name	Darajat Control Room
Location ID	
Facility/Site	GPO Darajat
LA OPG	GPO
LB OU	DRJ
LC Area	DRJ
Room Type	Control Room
Facility Status	ACTIVE
HMI Exist	YES
HMI with Control Capability	YES
Last Check Date	6/6/2014
Checked By	Wahidin, Suratno
Verified By	
Evidence/Doc Link	
24x7 Manned	YES
Access/Lock	YES
Access Control Remarks	Using Acces Card
Access Control Score	100.00%
Log Book Exists	YES
Log Book Review	NO
Log Book Remarks	need to provide log book inside the room
Log Book Score	80.00%
Warning Banner on Monitors	YES
Warning Banner on Doors	YES
Entrance Condition	YES

Fig 8: Facility attributes 1

Door & Banner Score	100.00%
Air Condition	YES
Smoke / Fire / Heat Detector	YES
Smoke / Fire / Heat Detector Inspection	YES
Fire Extinguisher	YES
Fire Extinguisher Inspection	YES
Humidity / Temperature Sensor / Indicator	YES
Environmental Control Remarks	
Environmental Control Score	100.00%
Back Up Power Connected to PCN Devices	YES
Back Up Power Maintenance	YES
Back Up Power Work Properly	YES
Back Up Power Remarks	
Back Up Power Score	100.00%
Operator Shift Schedule	YES
Operator Shift Schedule Updated	YES
Dedicated Room	YES
Emergency Lighting	YES
Critical Cable Protected	YES
Good Ceiling Condition	YES
Housekeeping / Room & Rack Clean	YES
Other Remarks	
Other Score	100.00%
%Compliance Auto	96.67%

Fig 9: Facility Attributes 2

An example of compliance summary report of PCN facility can be showed up by Fig. 10. The compliance reports can be summ up or drill down base on facility area that will be reviewed. For example in figure 10, the PCN facility compliance report can be drill down until each PCN facility or can be summ up until each operation areas (Salak, Darajat, and NDC) even we can summ up the report until GPO OU.

We have developed similar features of compliance report and status for other subjects (Controller, System, Computing, and Network). Overall the compliance summary of PCN system by Operating Unit can be presented by Fig. 11.

4. Conclusion

By implementing PCN Standard Image and PCN compliance dashboard, we can improve significantly PCN compliance and compliance evergreen processes. Beside that PCN system reliability improved by 17% average and safety of PCN personnel improves very well by reducing mileage during evergreen activities.

Location Name	Facility Status	Room Type	24x7 Manned	Last Check Date	Checked By	%Compliance Auto
LA OPG : GPO (53)						
LC Area : DRJ (21)						
Darajat Control Room	ACTIVE	Control Room	YES	6/6/2014	Wahidin, Suratno	96.67 %
Darajat Relay Room Unit 1	ACTIVE	Multi-Device Room	NO			0.00 %
Darajat Relay Room Unit 2	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat Relay Room Unit 3	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat HPU Circulating Unit 2 Area	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat HPU Circulating Unit 3 Area	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat HPU Steam Field Unit 2 Area	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat HPU Steam Field Unit 3 Area	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat EDG Basecamp Area	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	88.33 %
Darajat Compressor Room Unit 3	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat Switch Gear Room Unit 2	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat Switch Gear Room Unit 3	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	95.00 %
Darajat Cipanday Pump Area	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	88.33 %
Darajat Steam PAD - 2	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat Steam PAD - 3	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat Steam PAD - 4	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat Steam PAD - 14	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat PCV Station M	ACTIVE	Outdoor	NO	6/6/2014	Wahidin, Suratno	100.00 %
Darajat Computer Room	ACTIVE	Server Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat HVAC Room for Unit 2	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
Darajat HVAC Room for Unit 3	ACTIVE	Multi-Device Room	NO	6/6/2014	Wahidin, Suratno	96.67 %
LC Area : MCTN (9)						
LC Area : SLK (23)						

Fig. 10: Facility Compliance Score

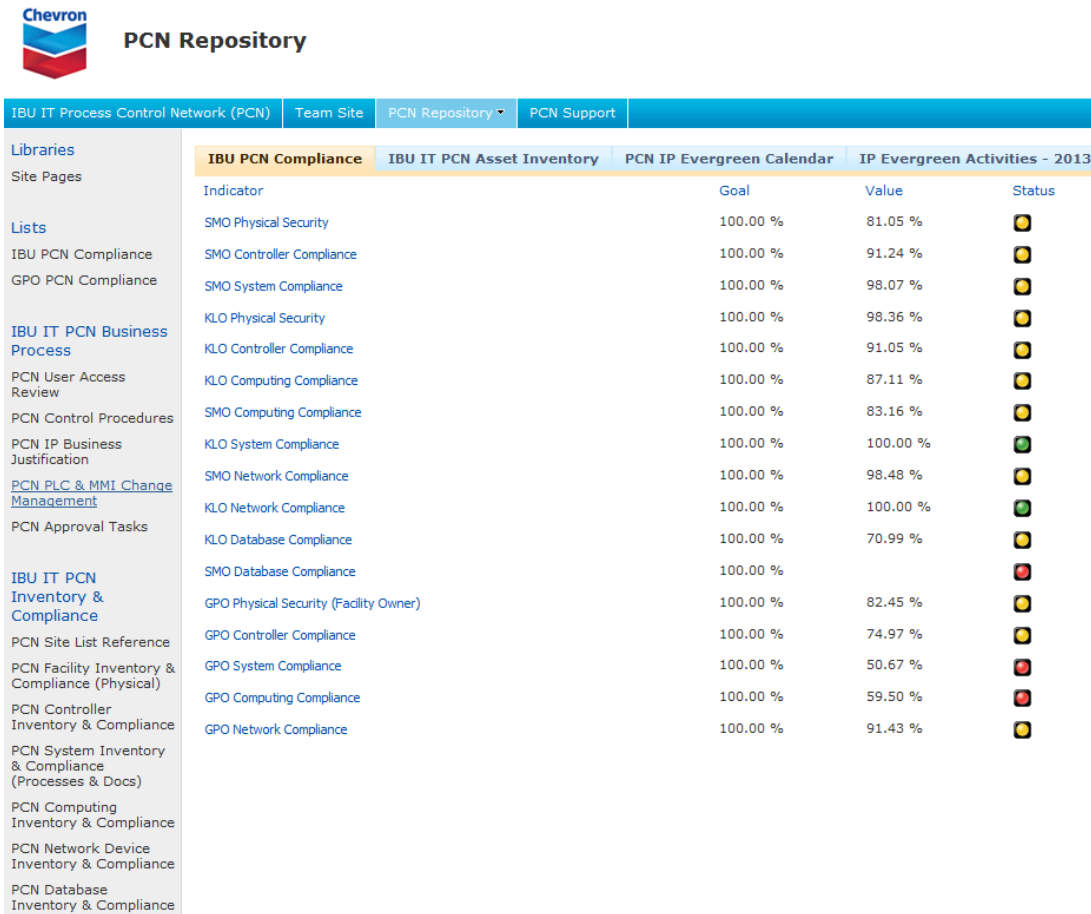


Fig. 11: Compliance Dashboard

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