27th WORLD GAS CONFERENCE | JUNE 25-29 | WASHINGTON DC | 2018
IGU

Pipeline Integrity Management: Conventional or Digitalisation & Intelligent?

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Group Technical Solutions, PETRONAS Project Delivery

HOST ASSOCIATION
AGA American Gas Association

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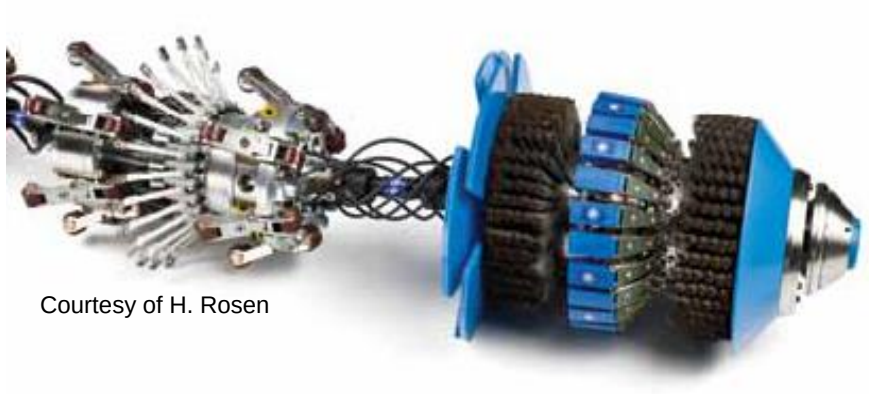
PETRONAS operates more than 10,000 km of pipelines (73% offshore & 27% onshore). Many intra platform pipelines (< 5 km) have serious inspection issues

Courtesy of www.theodora.com

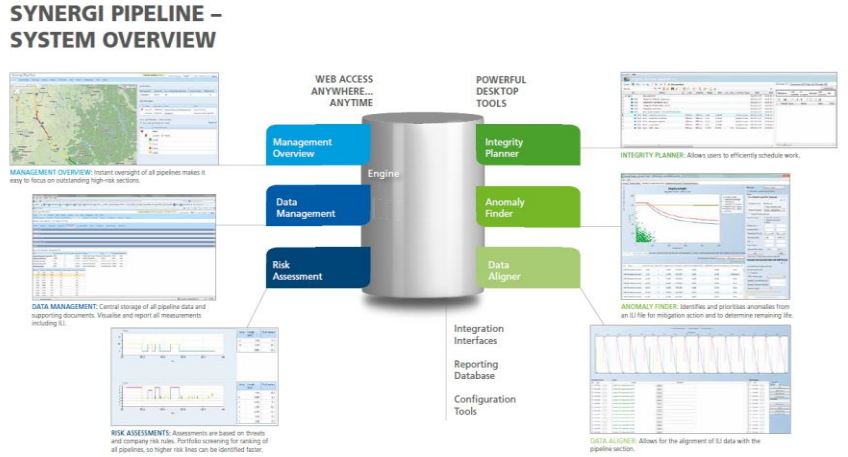
- No pigging facilities e.g. launcher & receiver (modification).
- Low pressure, low flow require auxiliary pumping.
- Deferment due to shutdown.

In addition to that, current inspection technology and system/software have limitations…



Courtesy of H. Rosen

- For non ideal case, require shutdown and auxiliary pumping.
- Multiple pigging activities that can disrupts operations.
- For ‘un-piggable’ pipeline, intelligent pigging (IP) requires modification that incurred additional cost.
- Specific IP tool can only inspect specific pipeline defects.



Courtesy of DNV GL

- No continuous and real time risk and integrity prediction.
- Lack of ‘intelligence’ in current PIMS system/software.

Thus, PETRONAS develops i-PIMS™ (Intelligent Pipeline Integrity Management System) to address the issues plaguing PETRONAS' pipelines

PHASE 1

Courtesy of TWI

NEW SENSOR TECHNOLOGY (ULRAT)

Courtesy of BIG DATA

"BIG DATA" DATABASE

Type of data: IP history,
Online operation data
Online inspection data

PHASE 2

Courtesy of Google.com

ANALYTICS/ARTIFICIAL INTELLIGENCE SYSTEM

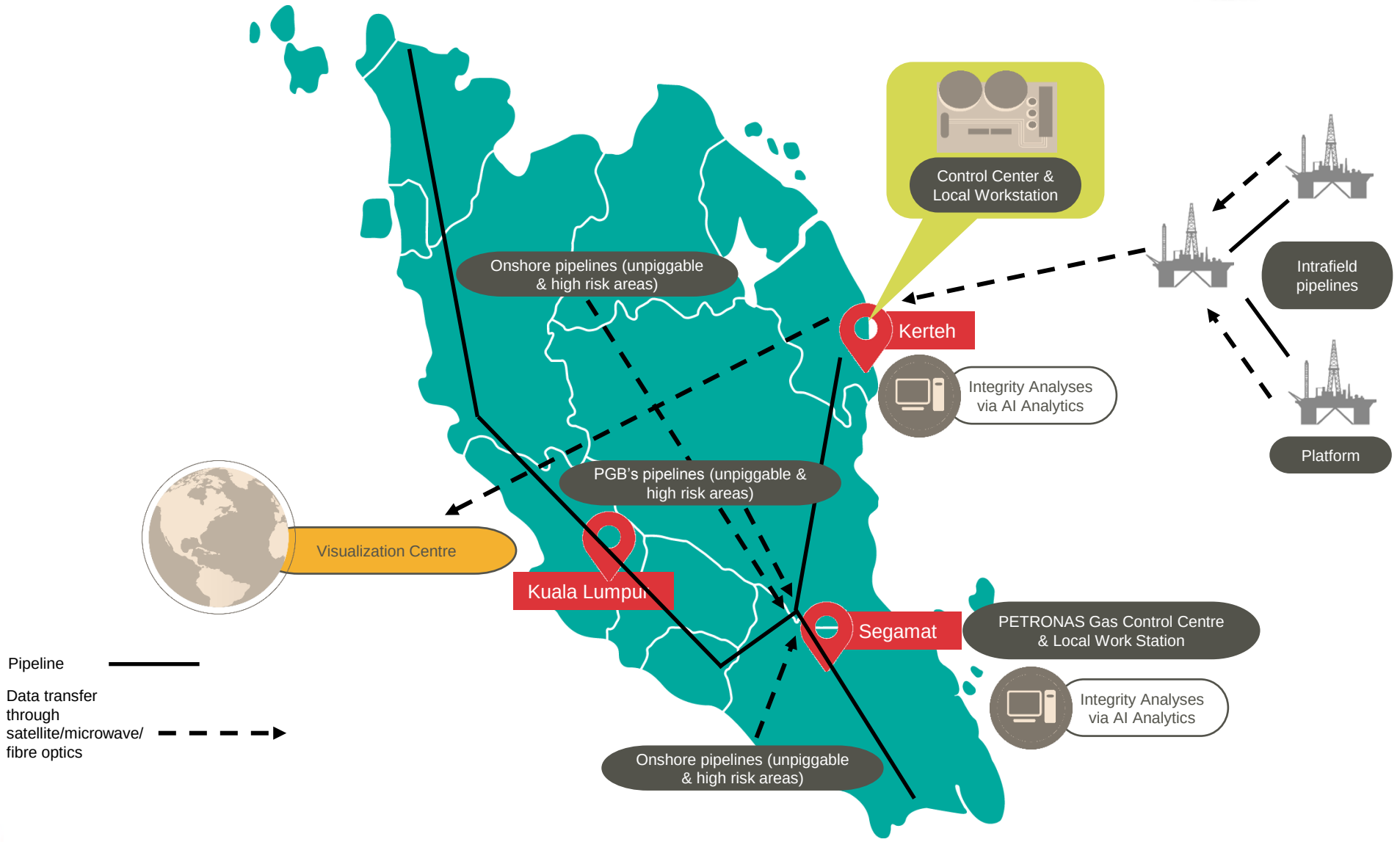
- **INTEGRITY HEALTH STATUS**
- **RISK STATUS**
- **REPAIR PLAN**

PHASE 3

ROBOTIC REPAIR TECHNOLOGY

Courtesy of Universiti Teknologi PETRONAS

The operational concept of i-PIMS™ will be on-line data extraction at the platform/field transferred to central data center for analyses and real-time integrity status monitoring



Ultra Long Range Acoustic Technology (ULRAT™)

Courtesy of TWI & Velosi

Existing Technology:

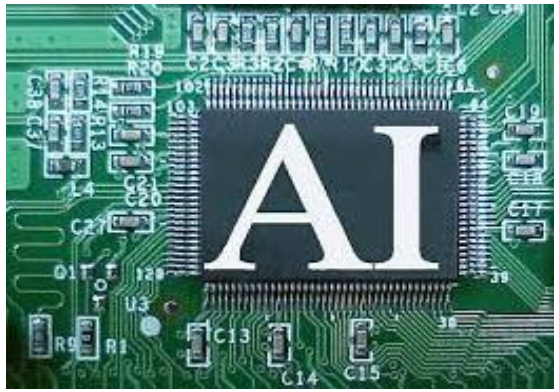
- It is a LRUT (long range ultrasonic) “clamp-sensor” only applicable up to 300 m length.

ULRAT™ Development:

- Developed based upon existing acoustic technology.
- Using concept of LRUT and infrasound capable to inspect up to 2-3 km per sensor.
- Provide real-time data from continuous monitoring.
- Sensors are able to operate across a wide range of temperatures from -40°C to +125°C, onshore & offshore.

i-PIMS™: Revolutionizing Pipeline Integrity Management

Artificial intelligence minimizing human interventions in performing super-complex analyses and assessments



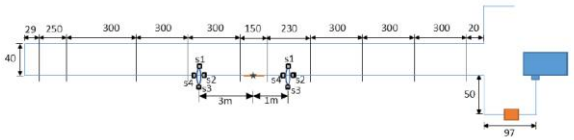
Courtesy of Google.com

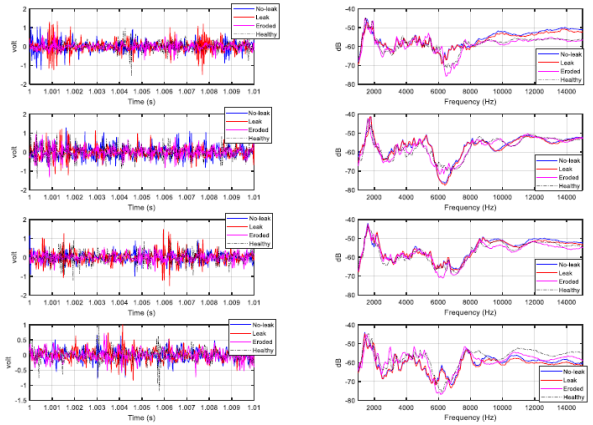
- Artificial intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans.
- For i-PIMS™, AI will be used to:
  - ✓ Emulate expert opinion / thoughts / judgment / knowledge
  - ✓ Refine risk and integrity analyses for accurate prediction of pipeline time to failure/remaining life
  - ✓ Facilitate real-time and ‘split-second’ decision making in the event of changing in operating parameters
  - ✓ Knowledge-based for ‘PIMS Advisory’

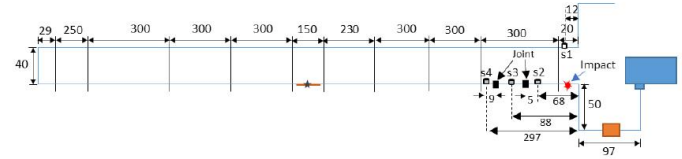
PETRONAS collaborates with local universities in developing i-PIMS™ with specific scopes for each party

PETRONAS	UNIVERSITI TEKNOLOGI PETRONAS	UTM UNIVERSITI TEKNOLOGI MALAYSIA
1. Overall R&D project management. 2. Pilot and commercialization. 3. Establish of procedures and guidelines for field application.	1. To study on the suitable techniques to automatically collect data on the pipeline status via Ultra Long Range Acoustic Technology (ULRAT™). 2. To design and develop mechanisms that can analyse acoustic waves' velocities of corrosive pipeline. 3. To verify and evaluate the proposed mechanisms. 4. To research on Big Data and AI with regards to the pipeline monitoring, and integrity management.	1. To research on probabilistic techniques with regards to the pipeline monitoring, prediction and integrity management. 2. To develop a prediction and decision making system based on probabilistic technique for pipeline integrity.

Currently, Phase 1 i-PIMS™ is in progress and targeting to achieve Technology Readiness Level (TRL) 4 by end of 2018







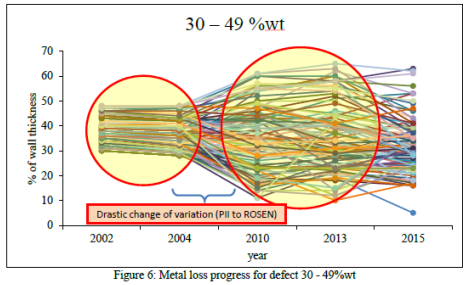


Figure 6: Metal loss progress for defect 30 - 49%wt

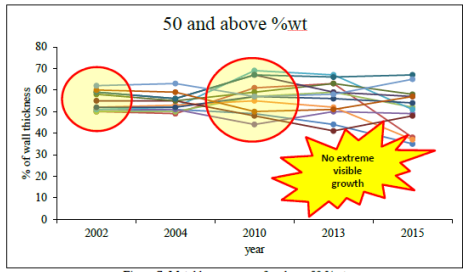


Figure 7: Metal loss progress for above 50 %wt

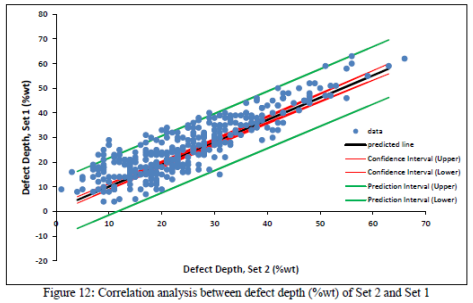


Figure 12: Correlation analysis between defect depth (%wt) of Set 2 and Set 1

Table 20: Average and standard deviation of corrosion rate before and after removal of negative and zero corrosion rate

Matched Data	Uncorrected			Corrected		
	Average (mm/year)	Std. Dev. (mm/year)	Count	Average (mm/year)	Std. Dev. (mm/year)	Remaining data
SET 1 – 2	-0.064	0.264	344	0.186	0.137	140
SET 1 – 3	-0.016	0.091	344	0.071	0.054	136
SET 1 – 4	-0.015	0.062	344	0.048	0.039	123
SET 1 – 5	-0.013	0.048	344	0.036	0.031	123
SET 2 – 3	-0.001	0.120	344	0.097	0.075	163
SET 2 – 4	-0.004	0.077	344	0.062	0.047	154
SET 2 – 5	-0.004	0.059	344	0.052	0.033	145
SET 3 – 4	-0.011	0.166	344	0.124	0.108	147
SET 3 – 5	-0.007	0.136	344	0.098	0.075	165
SET 4 – 5	-0.001	0.307	344	0.238	0.188	161

Phase 2 – Predictive analytics and AI will kick start in Q1 2019 utilizing in-house expertise…

Courtesy of Google.com

Courtesy of Google.com

In conclusion, i-PIMS™ could simplify offshore and onshore pipelines inspection as well as deliver tangible benefits to PETRONAS

- i-PIMS™ will eliminate internal pipeline inspection, operation intervention and pipeline modification thus eliminating in-line inspection, shutdown deferment and modification to existing pipelines estimated at RM3-5 mill. per pipeline or RM45 – 75 mil. per year (typically 15 pipelines per year).
- i-PIMS™ can also be used as leak detection system since one of its intended design functionalities is detecting and locating leak.
- i-PIMS™ as PETRONAS Group-wide Standardized Engineering Solution (SES) thus economies of scale and savings can be realized group-wide.

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Thank you!