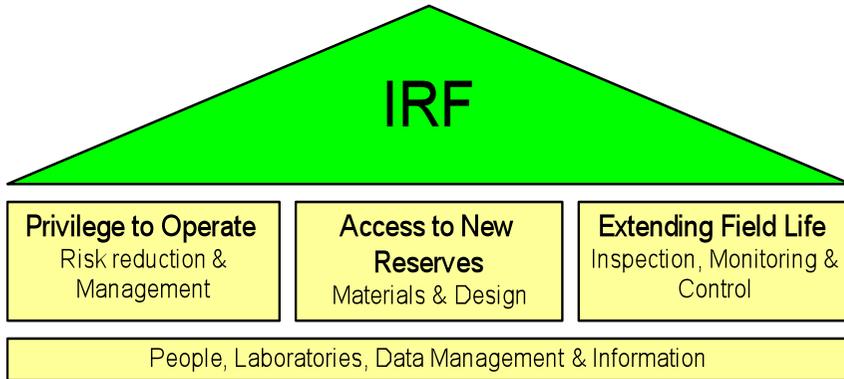




Surveillance

**UKOPA/
09/0058**

Inherently Reliable Facilities Overview



- Three Objectives:**
- Protect BP's privilege to operate
 - Deliver the recovery of **>1 bn bbls** of additional NP reserves through the extension of facility life & ability to handle fluids effectively
 - Create **~\$1.5 billion** NPV in Capex and Opex reduction

Key Technology Themes:

Material Selection & Performance

Defining and extending materials performance, including high strength casing, used on Rhum, and X-100 pipeline grade to enable economic gas transportation



Corrosion Management

Development of models including a mechanistic CO₂ model & enhanced erosion assessment tools, as used on high volume wells such as bpTT Mahogany

Defining and extending the performance of corrosion control and mitigation options



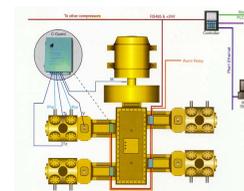
Monitoring, Inspection & Assessment

Development and application of novel monitoring, inspection and assessment tools, e.g. using digital radiography to enable BPXA to meet DOT requirements



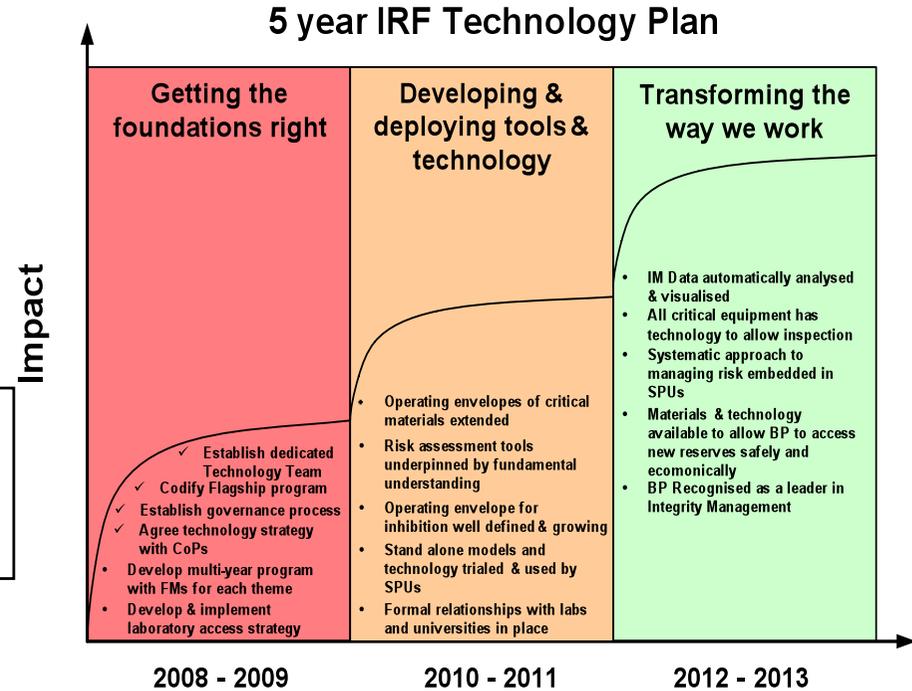
Maintenance & Reliability

Developing and delivering enhanced maintenance and reliability technology, including Windrock compressor monitoring tools



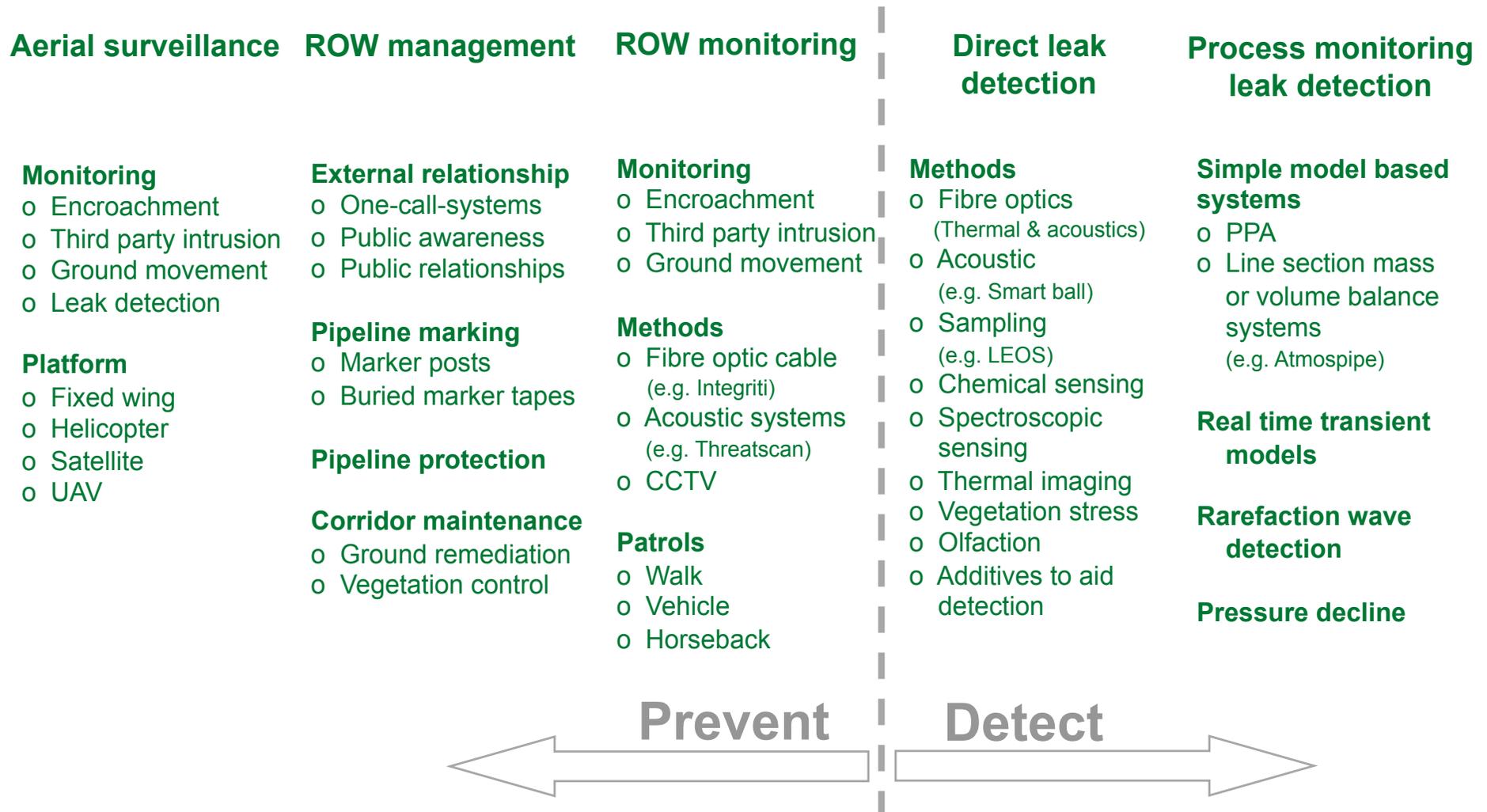
Information Management & Visualisation

Technology options for the remote gathering, assessment and visualisation of IM and reliability data, enabling Field of the Future and a potential step change in proactive IM and Reliability.



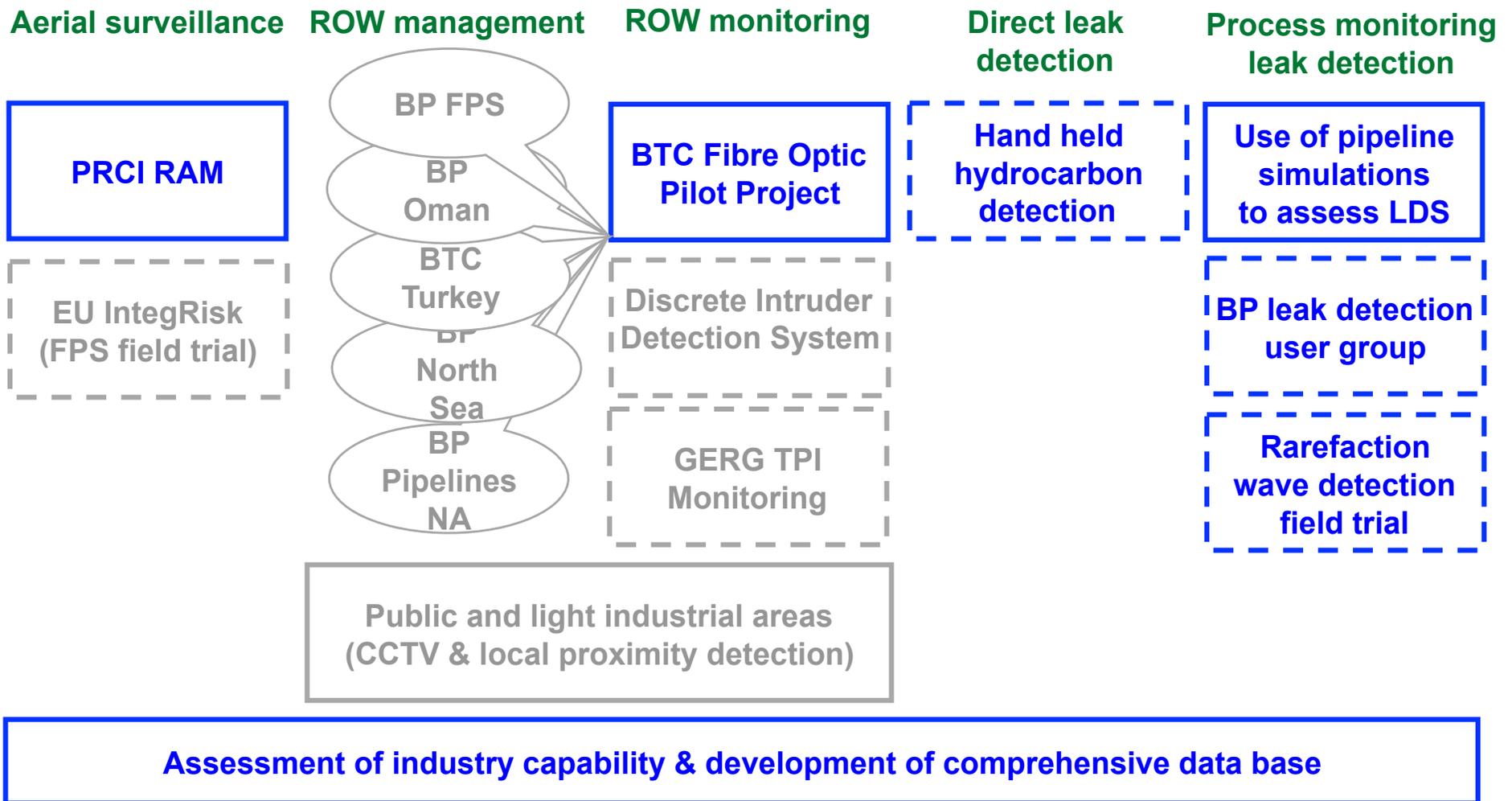


Surveillance





Surveillance





Aerial Surveillance

Advanced aerial automated monitoring technology



- Principal means of pipeline surveillance
- To monitor ROW for the following:
 - Threats due to machinery and other activities
 - Changes due to encroachment, ground movement, etc
 - Leaks
- Development of automated sensor and recognition systems for use on unmanned aircraft, fixed wing and satellite
- History of BP involvement in aerial and satellite surveillance technology activities
- Two major joint industry technology projects underway
 - PRCI RAM ~ Sensing equipment development (BP involvement)
 - EU IntegRisk ~ Sensing equipment and UAV trials

Leak Detection Trials



Field trials for gas leak detection

Number of proprietary systems

Platform

- Aerial: Helicopter vs. Fixed Wing Aircraft
- Vehicle
- Ground

Environment

- Wind Speed, Wind Direction
- Vegetation, Crops
- Precipitation, Snow Cover
- Temperature

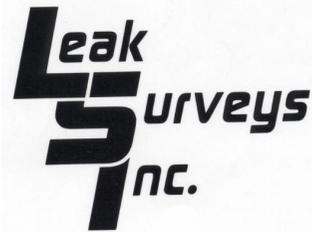
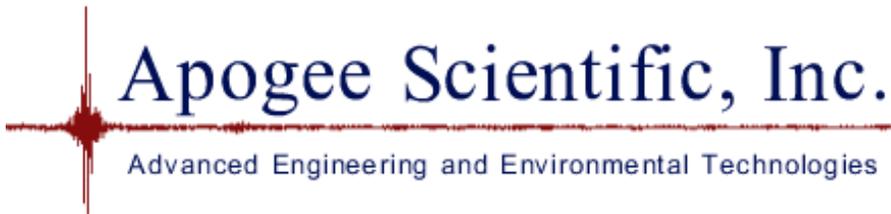
Pipeline operations

- Pressures
- Temperatures
- Soil Conditions

Criteria:

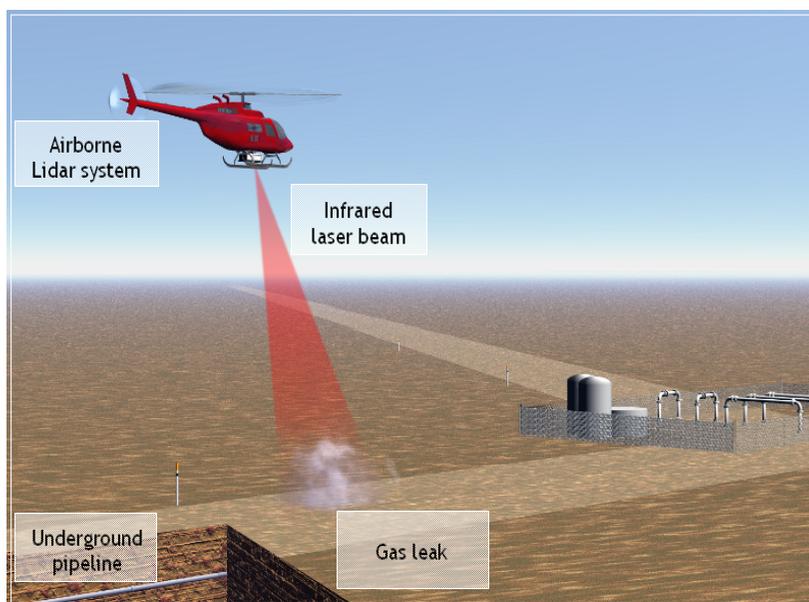
- Probability of detection
- Accuracy – false calls
- Real time reporting
- Cost per mile
- Operational safety

Aerial & Remote Leak Detection



Airborne leak detection

-Airborne Lidar Pipeline Inspection System (ALPIS)



Leak Surveys Inc. - IR Camera

- “The HAWK” System
- Gas Leak Imaging on Video

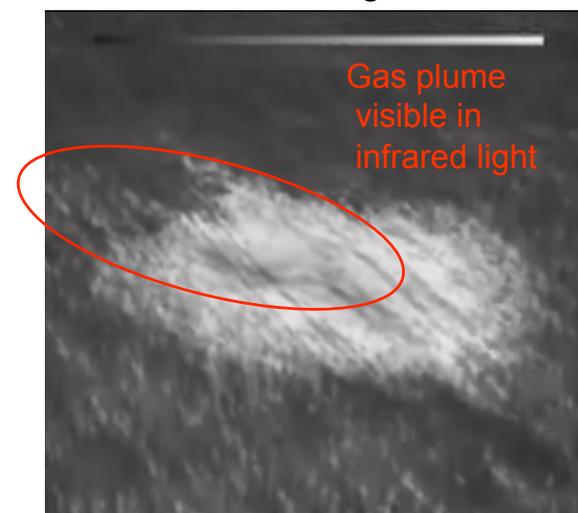


Aerial Leak Detection - Field Trials

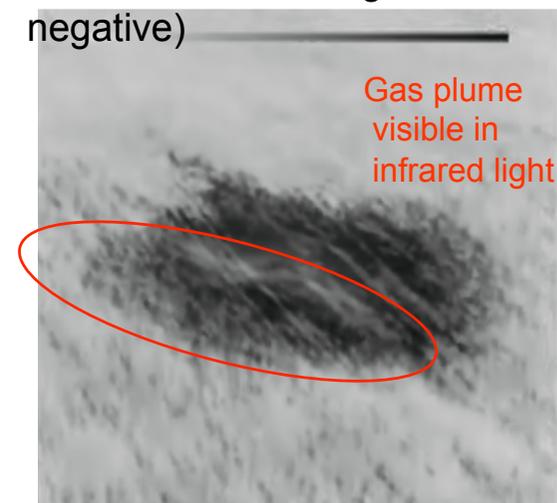
Found leak: hole in pipe section



Infrared camera image of leak area

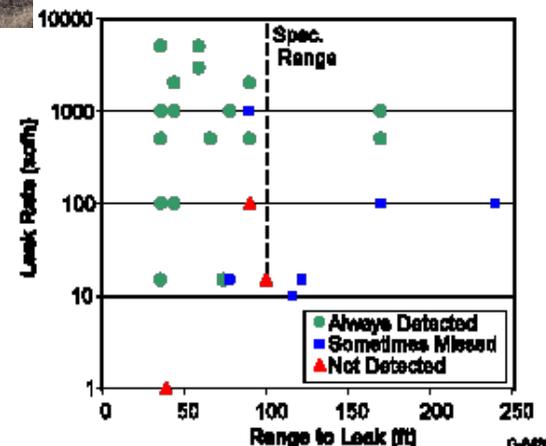
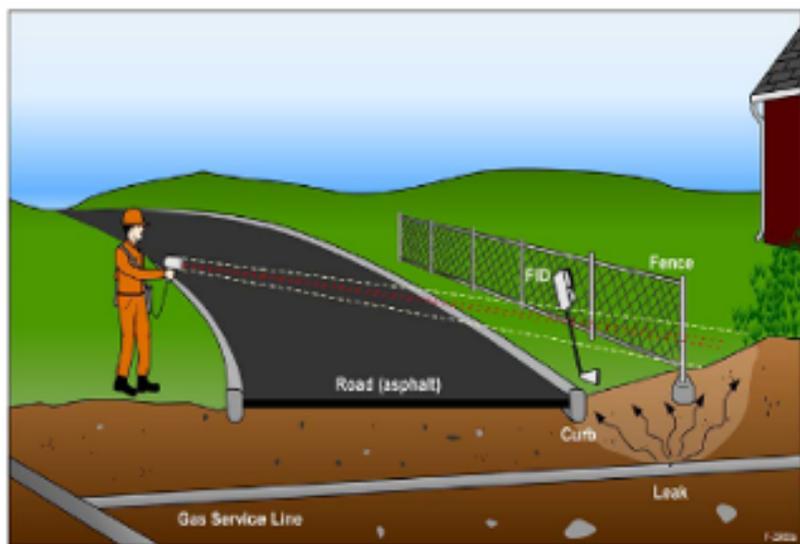


Infrared camera image of leak area (photo negative)

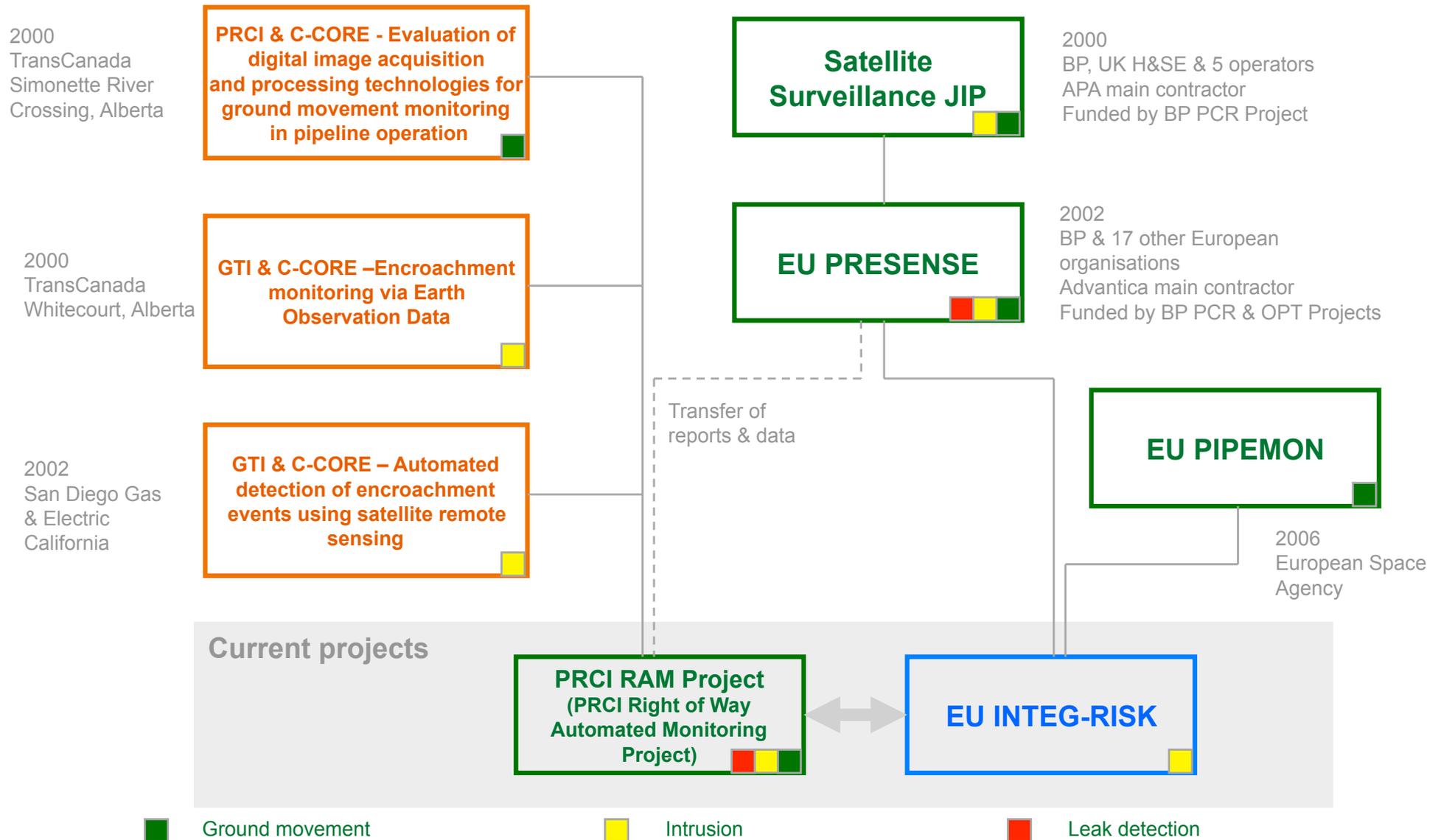


Ground Leak Detection

- Remote Methane Leak Detection (RMLD)
 - On the ground hand held portable laser system
 - Detect up to 100 feet away
 - Distances the field personnel away from gas leak



Technology project history



PRCI RAM Project Vision



Enhance aerial surveillance of the ROW through a suite of cost-effective sensors and technologies to prevent infrastructure damage.

Project Objective

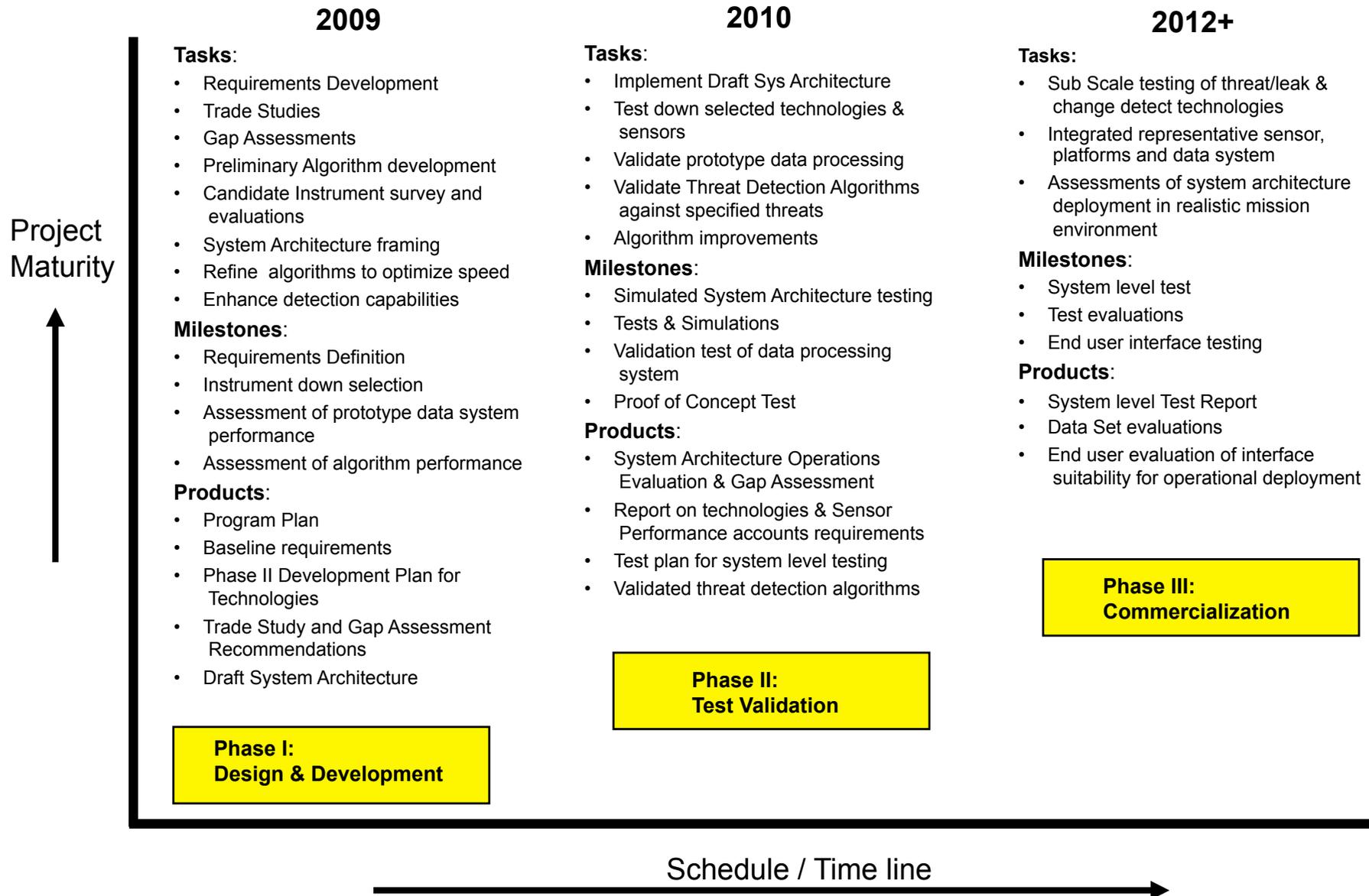
- Identify, validate and advance automated monitoring technology.
- Implement near term solutions on manned aircraft with a long term view to satellite and unmanned surveillance.



Automate Detection, Identification, Processing and Communication

- Machinery intrusions along ROW and under canopy
- Leaks along ROW and under canopy
- Changes along ROW and under canopy

PRCI RAM Phase Approach



Sensor technologies



Optical sensors

- Thermography
- High resolution imaging sensors
- Hyperspectral sensors

Ground

Intrusion

Intrusion &

Leak

Radar

- Imaging radar (Synthetic Aperture Radar)
- Interferometric SAR

Intrusion

Ground

Light detection and ranging (LIDAR)

Ground

Differential absorption LIDAR (DIAL)

Leak

RAM Progress



GAP analysis of sensor technologies

Leak detection

- Underground leak detection automation project
- Studying algorithms that automatically analyses hyperspectral imagery for vegetation affected by a gas leak
- Successfully discriminated leak induced plant stress caused by a leak from other plant stresses due to trampling, equipment, etc.

Pipeline threat

- Flight testing of a digital camera mounted on a BP Cessna aircraft
- Addressing motion/vibration blur and over-exposure with improved images
- Threat detection algorithms applied to new imagery
- Low rate of false negatives but too many false positives
- Development continues

EU IntegRisk



EU funded project called **EU 7th Framework Programme project IntegRisk - Early Recognition, Monitoring and Integrated Management of Emerging, New Technology Related Risks.**

In EU speak,

***INTEG-RISK** is a large scale integrating project aimed at improving the management of emerging risks, relating to new technologies in European industry. This will be achieved by building new management paradigm for emerging risks as a set of principles supported by a common language, agreed tools & methods, and Key Performance Indicators, all integrated into a single framework. The project aim is to reduce time-to-market for the lead market EU technologies and promote safety, security, environmental friendliness and social responsibility as a trademark of the EU technologies. The project will improve early recognition and monitoring of emerging risks, seek to avoid accidents caused by them and decrease reaction times if major accidents involving emerging risks happen.*

European Gas Research Group (GERG) has a minor role as disseminator of final data

Suez GDF and Enagas have direct participation in project. Preferred to PRCI RAM Project by Suez GdF.

IntegRisk – Pipeline Scope



Automated surveillance of a pipeline ROW for TPI. The objective is to provide an industrial system for deployment by drones (UAV) with automated image processing to identify threats. Intention is to trial systems using UAV in 2009 and 2011.

The expectations are:

- Reliable flight, no missed images
- Good resolution and accurate geo-referencing
- Automated image processing (limited human checking)
- Extensive operational validation (Suez GdF, France & Enagas - Spain)

Reach a satisfactory level of acceptance for industrial operation:

- Accepted by European Civil Aviation Authorities
- Check on regulatory and standardisation framework
- Check on acceptability to general public

Uses visible and IR cameras with automated image processing



Challenges



- Good potential for enhancement of surveillance from PRCI RAM and EU IntegRisk projects
- Reduced risk from manned flights by reducing personnel or using drones
- Seek opportunities to use sensing technologies across BP as they become available
- Investigate the challenges to use of drones in the UK
- BP is directly involved in the PRCI RAM project and is seeking a more direct involvement in the EU IntegRisk project

What are the permitting and approval processes for use of unmanned drones in the UK?

What operational advantages would there be from using unmanned drones?