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REVIEW OF LINEPIPE TAGGING AND TRACKING TECHNOLOGIES FOR ON AND OFFSHORE PIPELINE FABRICATION – 2061

Luca Piedimonte, Roberto Piancaldini, **Gianluca Mannucci**
RINA Consulting-Centro Sviluppo Materiali S.p.A., Rome, Italy

Martin Connelly
LIBERTY PIPES (HARTLEPOOL) LTD, Hartlepool, United Kingdom

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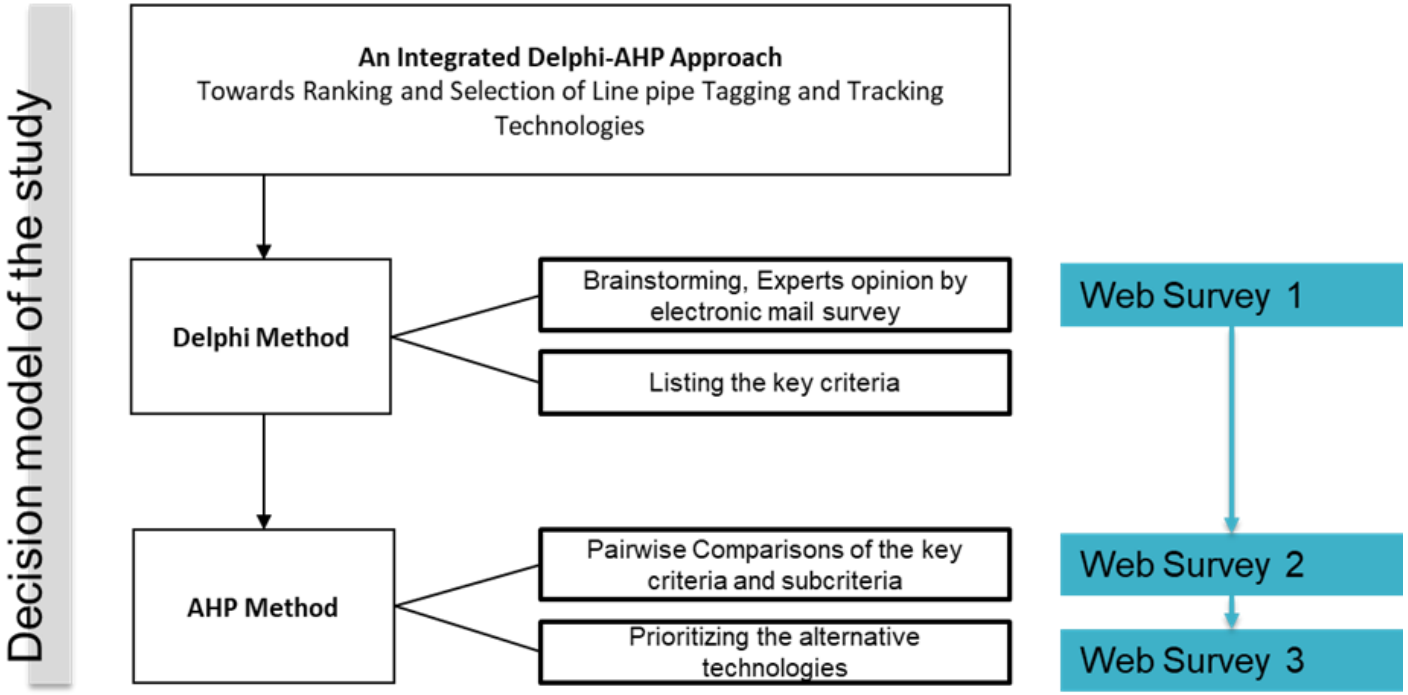
Study Objectives

- To carry out a state-of-the-art review of available pipe tagging and tracking technologies to identify the requirements for a potential common non-proprietary platform for use by all stakeholders.
- Identification of a standardized system which has the capacity to automatically read the identity details and to capture the data. The identity tag must have durability and integrity to withstand the processes that occur both during manufacture and subsequent operations including transferability at coating mills.

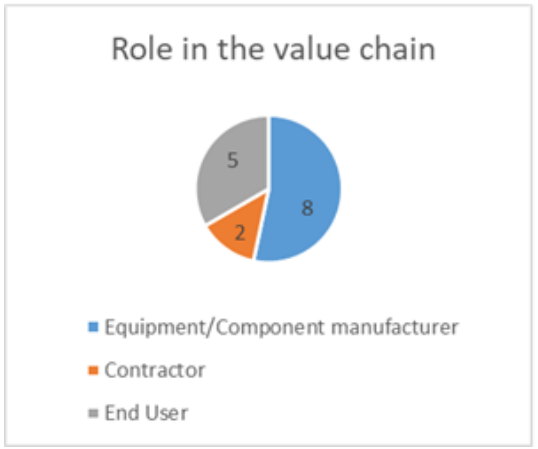
Approach

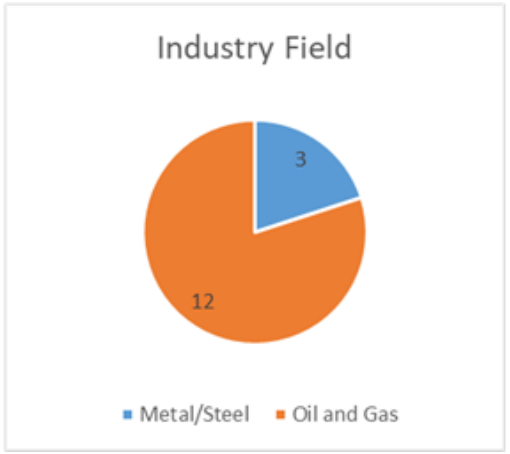


- The study is based on a decision model including an integrated Delphi-AHP (Analytic Hierarchy Process) method utilized to identify important requirements and their quantitative importance to realize a standardized line pipe tagging and tracking system
- Consultation, by online web surveys in several steps, of a Panel of Experts to collect the opinions and insights for identifying strategic recommendations for technologies selection.

Experts Panel

- The panel of EPRG Members was organized including 15 experts, with different expertise and belonging to companies and organizations working in the pipeline field All the participants accepted the conditions of treatment of the personal data according to art. 13 GDPR 679/16.





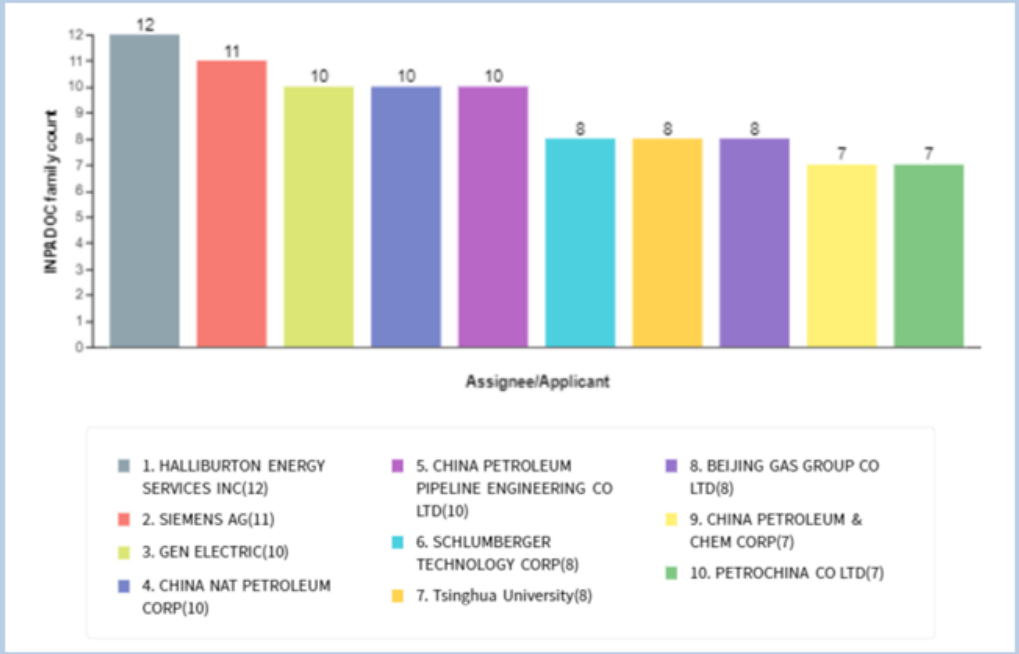
Definition of requirements

Requirements	Description
Tag installation	The start of the tagging process of the pipe, i.e. the manufacturing step in which the tag should be applied to start tracking (e.g start of the manufacturing process, before/after coating, end of manufacturing, before/after transport, etc.).
Data	Which data are needed to be included within the tag and the architecture to be defined to collect and properly manage them along the pipe lifetime.
Tag lifetime	The tag life span, i.e. the operating timeframe in which the tag system should be able to operate without compromising its features and capabilities.
Stress conditions	The typical operating conditions of the pipe, i.e. typical environment in which the tag is expected to be operated and the conditions it will be exposed to (e.g. offshore, underground, etc.).
Database interaction	The expected kind of interaction between the new system and the existing legacy system, to properly manage the integration of a novelt system within already operating systems.
Tag geometry	The physical and geometric form of the tag as well as its location and positioning with respectr to pipe geometry (e.g. external, internal, inside coating layer, etc.)
Power supply	The suitability of including power supply to the tag solution (e.g. batteries to supply energy to active tags fro remote or long-rage communication)
Pipe thickness	The possibility to locally reduce pipe wall thickness to embed the tag on the inner or outer surface of the pipe, e.g. creating a groove to host the tag.
Suitability to the fabrication process	The possibility to tag the pipeline during/after manufacturing with minor modification to the production process itself, assuring unchanged mechanical/operating properties of the final product.
Data reading and retrivial	The possibility to access tag data through a reader device remotely or in close proximity, in accordance to final pipeline location.

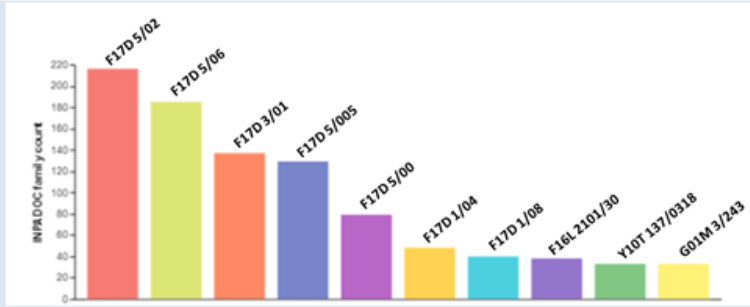
IP Scenario analysis – Pipelines tagging and tracking

Query	Title: « tag* OR track* » AND IPC Code: F17D
Search Results	3.332 Records – 1.624 INPADOC families (2015-2021)

Top Assignee



Top IPC Codes



F17D 5/02	Preventing, monitoring, or locating loss
F17D 5/06	Preventing, monitoring, or locating loss using electric or acoustic means
F17D 3/01	Arrangements for controlling or supervising the conveyance of a product
F17D 5/005	Protection or supervision of gas pipelines
F17D 5/00	Protection or supervision of installations
F17D 1/08	Pipe-line systems for liquids or viscous products
F16L 2101/30	Inspecting, measuring or testing pipes
Y10T 137/0318	Fluid handling processes
G01M 3/243	Investigating fluid-tightness of pipes

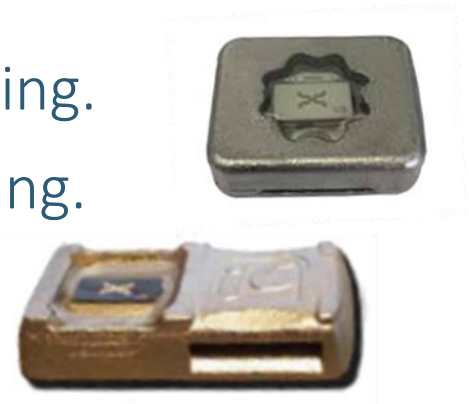
Patents alalysis

Country distribution of patents

- China represents the most active country in terms of published patents followed by the United States. European patents (EP) cover a relevant share of total with an important contribution by Germany

Technology survey – tag sensor availability

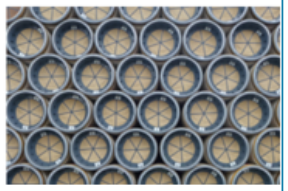
- Standardized stencils to enable reading by camera
- Bar codes – either label based or etched onto the pipe/factory coating.
- QR codes – either label based or etched onto the pipe/factory coating.
- Passive RFID – no battery backup.
- Active RFID – battery backup built in
- Combination of Barcode/QR and either active/passive RFID



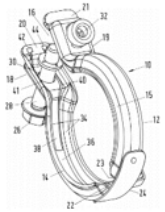
Special RFID tag for pipe application

Technology survey- commercial and research solution

Commercial solution for pipe tracking

Solution Provider	Short Description	Sector	Figure	Strength Points
EchoRFID www.echorfid.com	Method and software tool for collecting and organizing RFID data from utility assets, including pipelines. It uses passive UHF RFID tags installed on the pipes	Asset management software and solutions		Integrated software-hardware solution for data collection after pipe installation
Shawcor https://www.shawcor.com/iline	RFID end caps technology, in order to tracking and tracing pipes from manufacturing to installation, protecting at the same time the system from damage.	Asset management and inspection		Traceability of pipe data from the end of manufacturing to installation

Patents and solution for tagging

Solution Provider	Short Description	Sector	Figure	Strength Points
Xerafy https://www.xerafy.com/	RFID tags added to existing inventory as a retrofit, or directly embedded by manufacturers in their tools, equipment, pipes and other field assets.	O&G, Drilling		External RFID tag embedded in a groove No modification on the external geometry, with modification on pipe section
NOV Inc. https://www.nov.com/products/tracid-drill-string-life-cycle-management	Field-proven RFID technology and proprietary software solutions, Tags are installed during manufacturing or retrofitted into existing drill pipes.	O&G, Drilling		External RFID tag embedded in a groove No modification on the external geometry, with modification on pipe section
Norma Germany Gmbh Patent: WO2021023705A1	A clamp system with RFID for asset identification, in which the RFID is activated only in case the clamp is closed	Engineering, automotive.		RFID embedded in pipe clamp
Tile Tracker https://www.thetileapp.com/en-us/	Companion mobile app for smartphone to track the devices and locate lost items through Tile (tag) Bluetooth 4.0.	Consumer electronics		NFC solution for object tracking and tracing, with high accuracy. Active solution need power supply (e.g. batteries)

Selected/analyzed more than 50 hardware/software products and innovative application ideas (patents)

Expert Panel Final review

- The experts panel has been involved into an online final web survey based on the results of technological analysis of R&D and commercial solutions regarding tagging and tracking systems for pipes. The main important nine topics have been extracted from the previous studies in order to submit them to the different stakeholders of O&G pipeline, from production to commissioning

1 - When to start the tagging process?

2 - Tag functionality

3 - Typical life span of a tag/pipe

4 - Typical environment/operating condition

5 - Interaction between new system and the existing legacy system

6 - Physical form and location for tag

7 - Need to avoid any localized reduction in wall thickness

8 - Concern if the tag requires to be powered

9 - Optical reading of tag

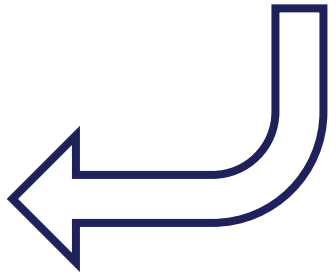
Definition of possible platform solutions

- Each Pipe Tagging & Tracking System solution has been defined through the combination of the technology/recommendation that matches with the specific requirement.
- The solutions share the same technology for the requirements of Tag type (RFID), Lifecycle (system available for more than 15 years) and Data Architecture (storage and management in cloud).
- Different approaches for the requirements of Tracking start (bare pipe or after coating), responsibility for the system management (manufacturer or industry body) and software integration (automatic or combined with manual operations)..

SWOT analysis for each solution

STRENGTHS	WEAKNESSES
- **Long lifetime (passive RFID)** - **Compact dimensions** - **No battery required** - **RFID is a robust and mature technology** - **Cheaper solution** - **No maintenance required** - **Cloud architecture enables remote data access** - **Tag protected by coating application, not subject to wear and tear**	- Short range communication - Need of an external reader device - Coating removal needed in case of tag substitution due to tag failure - Pipe manufacturer involved in the whole system management along the product value chain - Unlikely that tag could be applied and remain on pipe from start to end of manufacture due to contacts, environments and handling associated with pipe manufacture - May require multiple reapplications - Integration with legacy pipe tracking system at manufacturer
OPPORTUNITIES	THREATS
- **Automatic data entry should simplify data collection and aggregation** - **The coating enables the adoption of the tag in challenging environments (high pressure, temperatures)** - **Opportunity for manufacturers to provide a new service to the value chain**	- Difficulties for the adoption of the solution and the correct update of data along the entire value chain - Automatic data entry represents a technical challenge for manufacturer in charge of system management - Cloud architecture could be affected by external data theft or cyber attacks

	SOLUTION 1	SOLUTION 2	SOLUTION 3
Tracking Start	Bare pipe	After coating processes	After coating processes
System management	Manufacturer	Industry Body	Industry Body
Legacy SW Integration	Automatic data entry	Supplementary (manual & automatic)	Automatic data entry
Architecture	Cloud (European Pipeline Tracking Database)		
Life	>15 years		
Tag Technology	RFID		
Sensors	Passive	Active	Passive



SWOT analysis

STRENGTHS	WEAKNESSES
- **Long range communication** - **Direct communication with no need for external reader device** - **RFID is a robust and mature technology** - **Easy access for maintenance or battery change** - **Cloud architecture enables remote data access** - **The system management by industry body ensure data validation along the value chain**	- Shorter lifetime with respect to passive tags (in case of use of a battery) - Power supply needed (battery or wired) - Active RFID is a pricey solution - Larger dimensions - The tag may be exposed to wear and tear - Integration with legacy pipe tracking system at manufacturer
OPPORTUNITIES	**THREATS**
- **Opportunity for industry bodies to provide a new service to the value chain** - **Increased tag abilities with partnered technologies (GPS, sensors, etc.)** - **Supplementary data entry enables a short term adoption**	- The external tag must be protected by the end-user taking into account the environmental conditions - Cloud architecture could be affected by external data theft or cyber attacks - Supplementary data entry could be influenced by human factor (eg: errors, timing)

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Life		>15 years	
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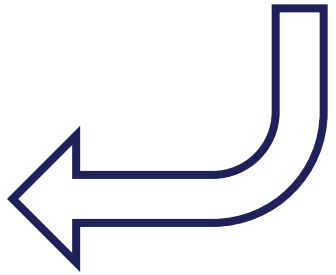

SWOT analysis

STRENGTHS	WEAKNESSES
- **Long lifetime (passive RFID)** - **Compact dimensions** - **No battery required** - **RFID is a robust and mature technology** - **Cheap solution** - **No maintenance required** - **Cloud architecture enables remote data access** - **Tag protected by coating application, not subject to wear and tear** - **The system management by industry body ensure data validation along the value chain**	- Short range communication - Need of a nearby reader device - The tag may be exposed to wear and tear - Integration with legacy pipe tracking system at manufacturer
OPPORTUNITIES	THREATS
- **Automatic data entry should simplify data collection and aggregation** - **Opportunity for industry bodies to provide a new service to the value chain**	- The external tag must be protected by the end-user taking into account the environmental conditions - Automatic data entry represents a technical challenge for manufacturer in charge of system management - Cloud architecture could be affected by external data theft or cyber attacks

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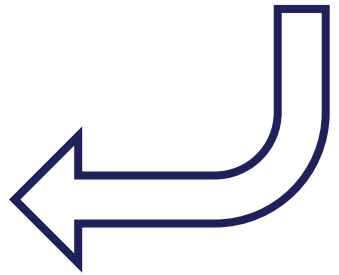


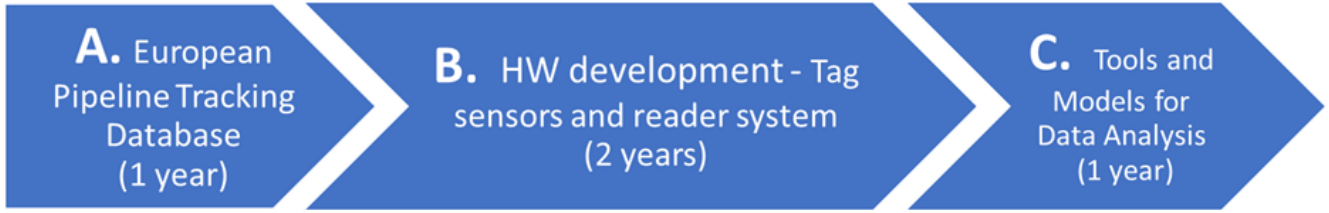
Favorite solution

Common question for implementation the best solution

- 1. When to start the tagging and tracking? (Including the definition of aspects related to managing the tag impact on the pipe/coating and the legacy systems at each manufacturer or other stakeholders affected)
- 2. What technology to use? (Including all the practical implications derived form the selection of a specific technological solution, e.g. passive/active, RFID/other, etc)
- 3. How to manage and access the tracking information? (Identify common strategies for data management and access, at different levels including European/Global approach or parochial to the single manufacturer)

Results

- Definition of 3 different solutions, with a clear favorite for adoption in the third one, in accordance with the requirements based on the robust and mature RFID technology, for pipe tagging, with its flexibility in the pipe application and its readability (non-contact technique).
- The data management should be organized in a cloud system in order to assure a common platform for real -time access that should be maintained for all piping supply chain cycle (> 15 years), from manufacturing of single pipe, its coating, girth welding and finally to its installation and maintenance
- Common European/Global Pipeline Tracking Database (EPTD) as repository of the pipe tagging & tracking data with interfaces for read and write it.
- Definition of a Roadmap



Thank you for your attention.