

## Task E: Smart gas infrastructure sensing of wells and pipelines

Sensing technologies makes ground-truth observations about infrastructure performance, grows trust in the predictive models, and add valuable information to the decision-making process. Subsections below summarizes sensing and monitoring technologies for gas storage wells and pipeline systems, which can guide development of OpenSRA technologies.

### Remote Sensing Technologies

Acquires information about an object (such as ground deformation) without physical contact. Selected technologies include LIDAR, InSAR, and Structure From Motion (using UAV, and Satellite photogrammetry).

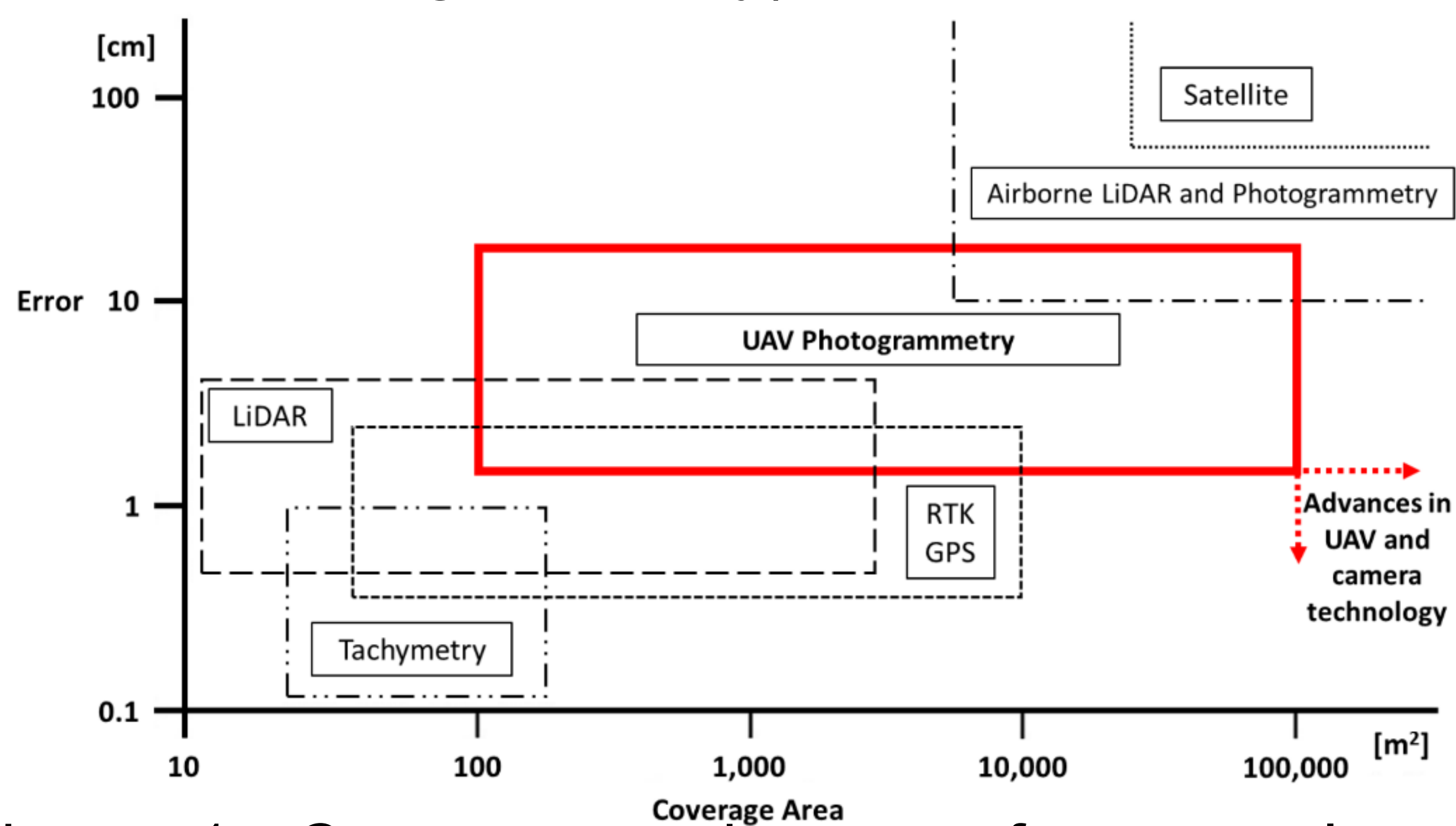


Figure 1. Coverage and error of commonly used remote sensing technologies (Greenwood et al. 2019)

### Continuous Sensing Technologies

Provides continuous measurements on the condition of the pipeline's infrastructure. Selected technologies include Distributed Fiber Optic Sensing (including strain, temperature, and acoustic sensing) and Wireless Sensor Networks (including strain, acceleration, soil moisture, and displacement sensors)

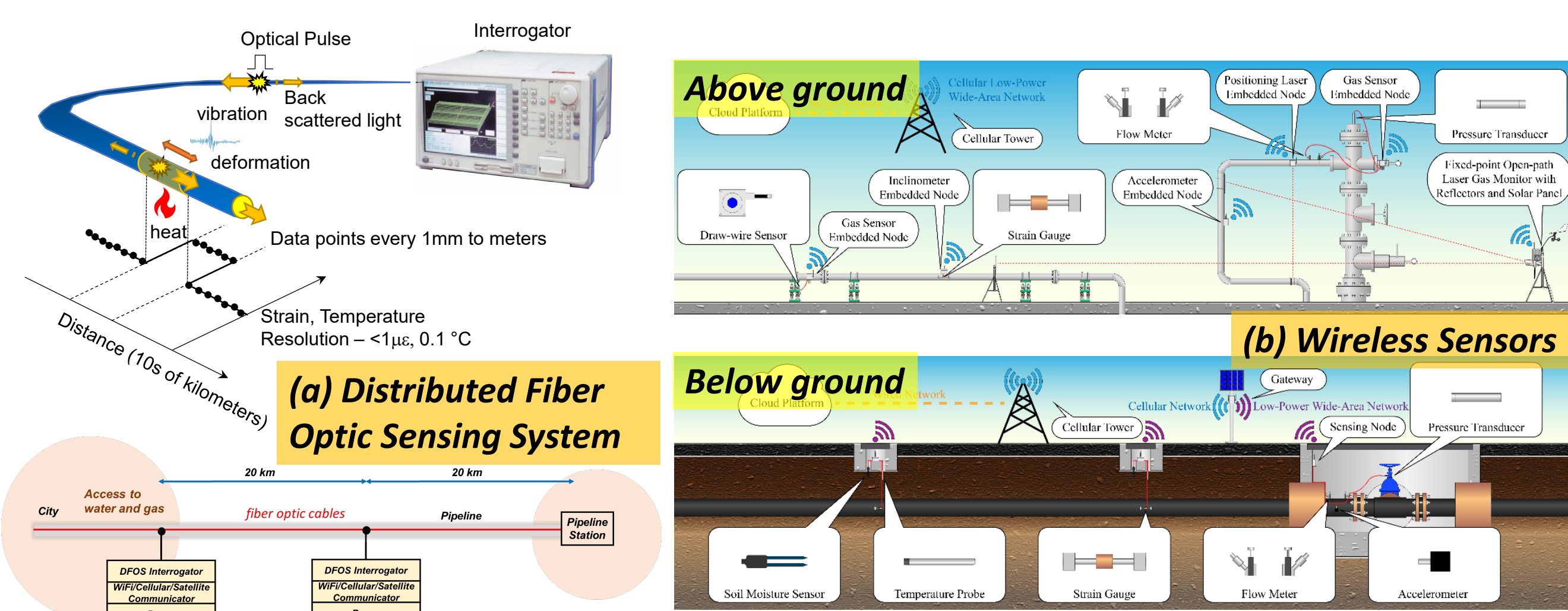


Figure 2. (a) Distributed fiber optic sensing system and (b) Wireless Sensor Network deployed above and below ground for gas pipeline monitoring

### In-line Inspection Technologies

Inspects the physical condition (such as corrosion, cracks, and damage) of pipelines (both internally and externally) for routine maintenance. Selected technologies include Smart Pipeline Intervention Gadgets (PIGs), magnetic flux, and ultrasonic testing.

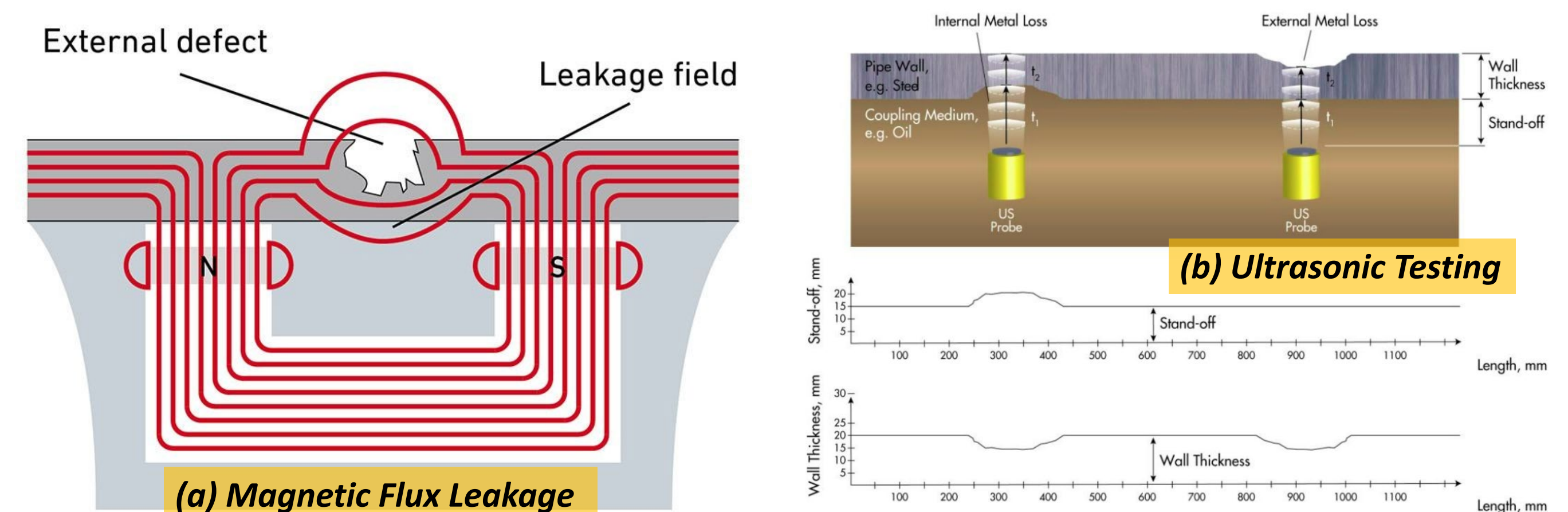


Figure 3. (a) Magnetic flux leakage (Rosen Group) detecting metal corrosion and (b) Ultrasonic testing detecting thickness of the pipeline (Barbian et al. 2011).

### Leakage Detection Technologies

Inspect leakages in the pipelines. Selected technologies include gas detection technologies (e.g.: Catalytic Bead, Nondispersive infrared, and tunable diode laser absorption spectroscopy) and flow detection technologies (e.g.: mass flowmeter, volume flowmeter, pressure meter, and displacement flowmeter )

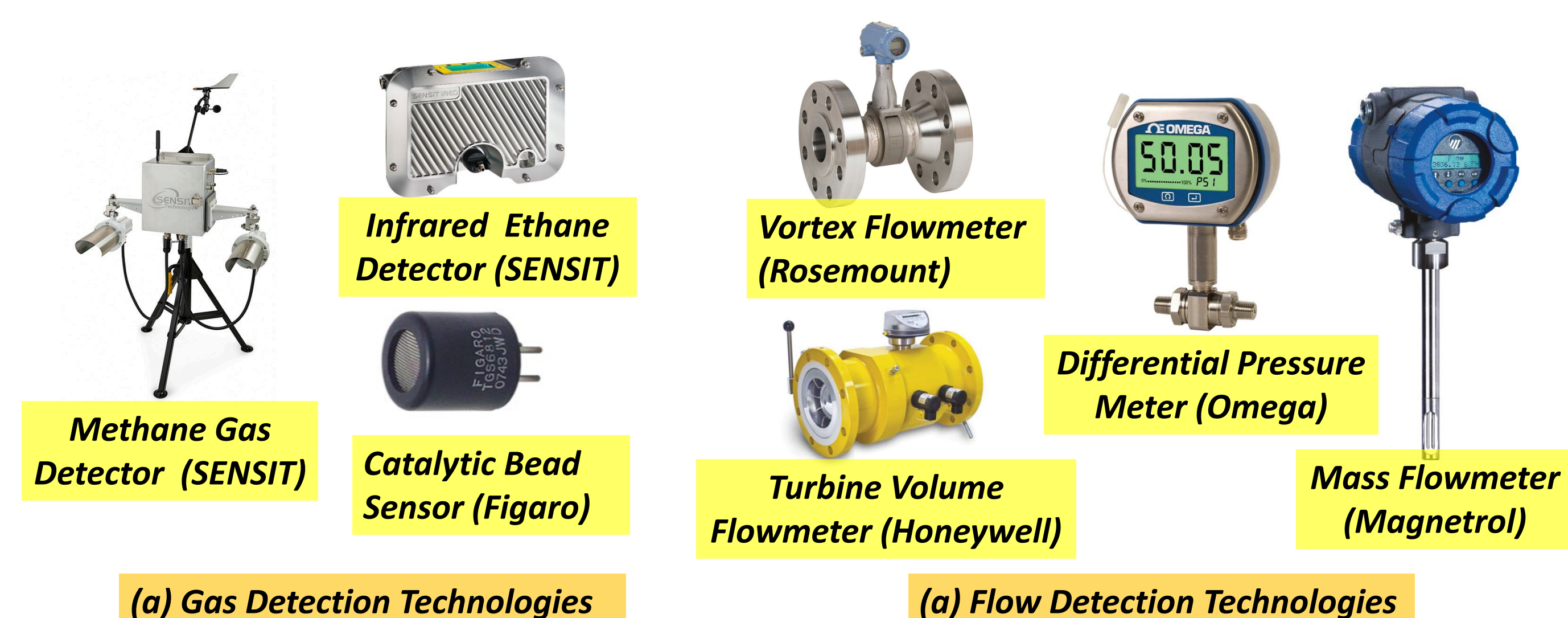


Figure 4. Common (a) gas detection and (b) flow detection sensors for detecting leakages in pipelines.