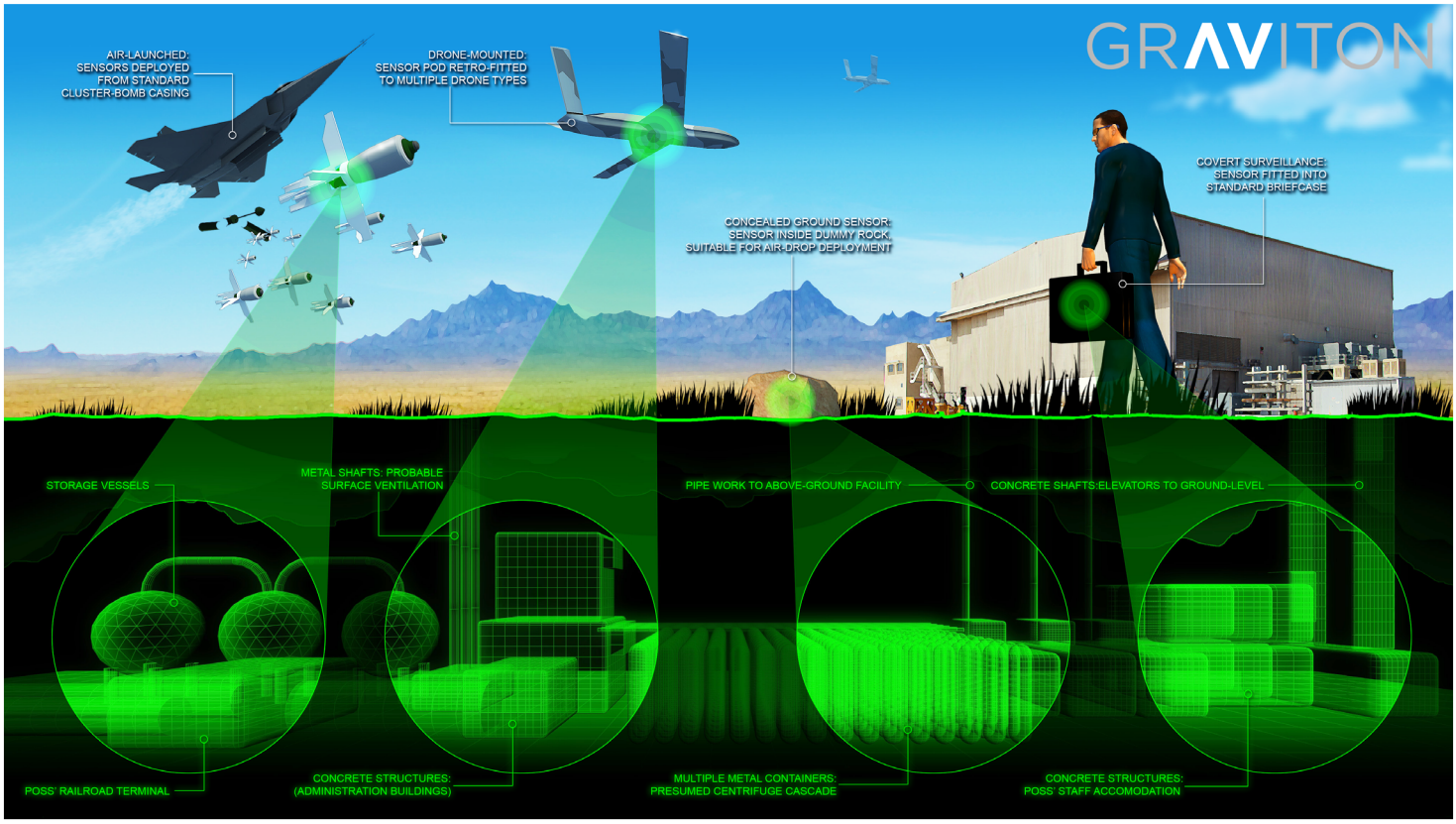


**GRAVITON**

A proposed system for the high resolution mapping and visualization of underground facilities and construction activities using remotely operated gravity probes.

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RÆLLIC SYSTEMS

**EXECUTIVE SUMMARY**

We propose to use an array of MEMS gravimeters delivered by any of several methods to generate high resolution maps of underground facilities and construction activities. This is accomplished by measuring the strength of the Earth's gravitational field at interesting locations with extraordinary precision. With three dimensional gravitational field strength measurement afforded by using an array of MEMS gravimeters plus traditional multi-axis accelerometers, the effect is anticipated to be similar to the volumetric visualization of anatomical structures in the medical imaging industry through passive imaging techniques. Detected anomalies would be marked for further measurement; multiple overflights of suspected underground facilities would exponentially increase the resolution of the generated underground map. Delivery methods at the present time are: (1) a special briefcase carried near the facility, (2) drone flights near the facility, (3) a cluster bomb of probes that fall through the air near the facility, and (4) disguised objects and buried sensors. The same system in a mobile configuration could be used as a GPS alternative by permitting gravitational navigation against a stored map of the Earth's gravitational field, without relying on satellites.

Current gravimeters are large, expensive systems that cost tens of thousands of dollars and require significant support and calibration. The MEMS gravimeter is almost as precise and is orders of magnitude smaller. This type of gravimeter was invented in 2016 in the UK, apparently by two different teams at different universities. The initial application was intended to be oil and gas exploration. A MEMS gravimeter is similar to an accelerometer, but is about 10,000 times more precise. This is precise enough to detect underground voids or tunnels, as well as equipment placed underground. The initial proof of concept by the inventors was measurement of ocean tides with high precision over an extended period, and a journal article on that subject appeared in the journal Nature in mid-2016. According to one of the inventors contacted by the submitting party, the MEMS gravimeter is currently in the prototype phase and will be in testing through approximately Summer 2017. Commercialization of the device depends on their team's ability to package the device in a chip. The current prototype is a 20 cm circuit board enclosed in a 10 cm vacuum chamber. The current prototype is small enough for the submitting party to build a complete system that works, although miniaturization will greatly increase the options for delivery. The submitting party is in active discussions with the inventors to explore options for purchasing and development. The other equipment needed to build the Graviton system is already available off the shelf, although software engineering will be required to integrate the other equipment and the gravimeters in a cohesive package.

**OTHER**

The submitting party would like to offer the government a proposal for the research and development necessary to accomplish Graviton. Depending on specific feature requests, the platform would cost between $300,000 and $500,000 to deliver, primarily composed of software engineering, research, and the acquisition of numerous MEMS gravimeters plus other equipment for prototyping and testing purposes.

**NEEDIPEDIA CAPABILITY AREA**

Graviton is responsive to "99.0 Underground Construction."