Internet of Risk Meters Platform as a Service

CURRENT PROBLEM

Ideation has more than two decades of professional experience in applying technology, data science, and engineering econometrics to compute complex hazard risk estimates for real-life use cases for communities at risk. We have assisted more than 5000 hazard risk management professionals across 44 states and a dozen union territories and tribal nations by estimating losses due to hazard events, estimating annualized risks in the future, preparing grant applications in compliance with federal and Office of Management and Budget (OMB) requirements, and reviewing hundreds of real-life project case studies. Through all these experiences, one of the most consistent themes we discerned was that **while communities across the world are facing ever-increasing risks to life and property due to natural disaster events, there is a chronic and acute shortage of reliable, site-specific hazard data** that would enable them to better prepare, respond, recover and mitigate against these hazard events.

Even with the proliferation of faster and cheaper hardware, software, and network technologies, **the biggest challenge still remains: the availability of data required for accurate risk estimation analysis.** Either the required data don't exist or, if they do exist, they are incomplete. If the data exist, either they are found across multiple sources (such as Federal Emergency Management Agency (FEMA) Hazus, United States Geological Survey (USGS), National Weather Service (NWS), etc.) or they are not at a high enough density or at a granular enough level (such as at a road crossing or structure) to simulate site-specific conditions. There are current remote sensing technologies (e.g., USGS stream gages) that can address the data capture problem. However, they involve permanent installations that require huge initial capital investments and several thousands of maintenance dollars over the life cycle of the sensor devices.

Even with the advancement in technologies such as Internet of Things (IoT) and the decreasing costs of hardware (sensor devices) and wireless communications, there are still many significant barriers for widespread adoption of remote sensing technologies. One type of barrier is the complexity involved in procuring, installing, calibrating, and configuring the sensor devices for local site conditions. Another barrier is the ability to maintain reliable data transmission across low-power networks.

Moreover, risks are not estimated in a holistic and predictive manner. There is a lack of readily available, site-specific risk estimates that fuse direct-sensed data with external-sourced data to accurately estimate risks. While there are many commercial entities that claim to accurately estimate risks and offer risk estimates or risk "scores," most of these estimates use a "black-box" approach with proprietary methodologies. The results of these proprietary models—how ever accurate they are—cannot be independently verified using Federally approved standard models, which is a significant requirement when seeking financial grant assistance for mitigation projects.

Thus, it is still very **cost prohibitive, time consuming and labor intensive to collect and analyze the high-density, granular hazard risk data needed to accurately estimate risks.**

OUR SOLUTION

Ideation has successfully created an **end-to-end solution to address the critical and urgent need for collecting reliable data to accurately estimate actionable risks and trigger timely alerts using direct, real-time, risk-metering sensors.** Using our experience, expertise and advanced research in multi-disciplinary engineering, data science, technology, training, Federal mitigation grant assistance, cyber security, and IoT implementations, we have developed the Internet of Risk Meters Platform (IoRMP). Ideation's IoRMP is a complete, secure solution that provides communities, first responders, and citizens with site-specific alerts and risk estimates (along with the underlying data) for a variety of hazard risk-related use cases. **Risk estimates are compliant with Federal requirements and industry standards.** The IoRMP is a modular platform that can be configured and expanded to meet the site-specific needs of a community.

Examples of use cases for the IoRMP where hazard data is collected and used for estimating risk include:

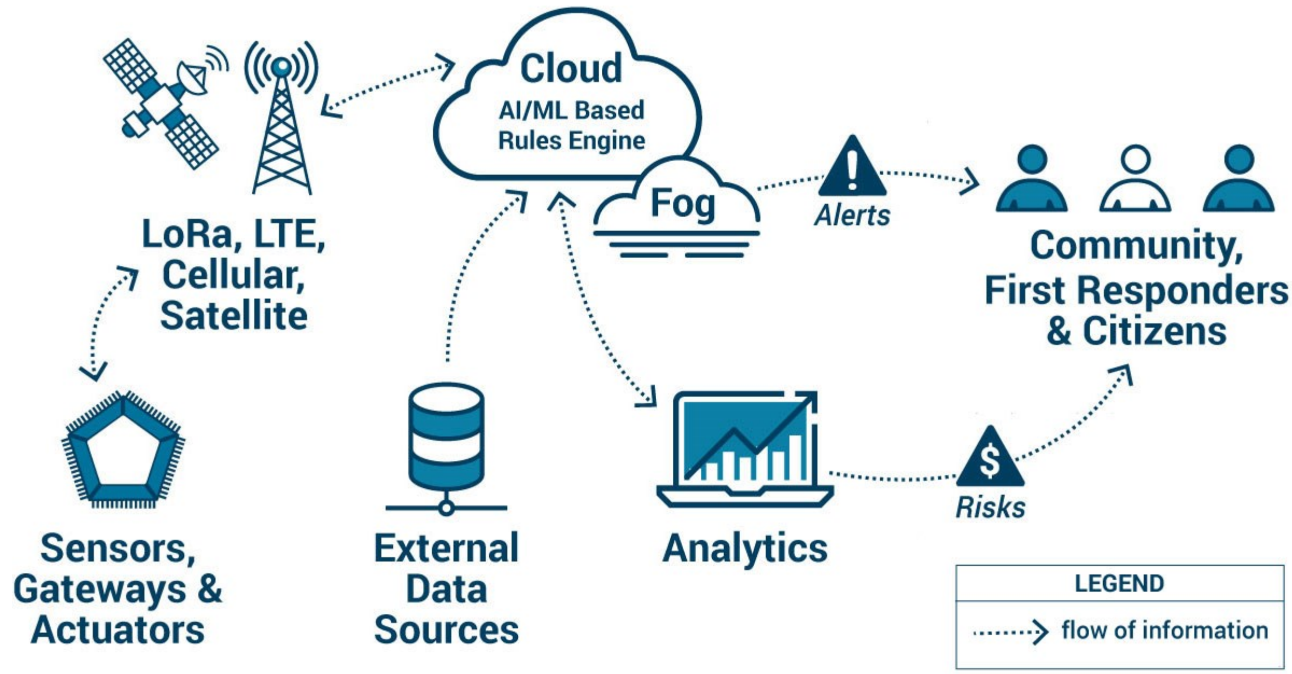
- Estimating economic losses due to specific hazard events that have occurred as well as predicting future risks.
- Providing accurate measurements of highly sensitive parameters such as a building lowest-floor elevation. Using multiple sensor data (fusing GPS location data, barometric pressure data, and local weather station data), we are able to accurately estimate the lowest-floor elevation of buildings (mean error ± 0.5 ft) with our portable sensor device.
- Providing predictive text alerts to warn commuters about road closures due to flash flooding and proposing alternate routes (through commercial apps such as Waze or Google Maps).
- Sending alarms for landslides or mudflows.
- Performing real-time wildfire monitoring.
- Using our open standards-based platform application program interface (API), communities can feed third-party applications to perform additional custom risk modeling and visualizations such as real-time development of inundation maps.

All these cases produce accurate hazard risk estimates

The Platform

Our IoRMP is a complete, end-to-end platform that consists of **low-cost, low-powered, high-precision, ruggedized sensors that are connected through a secure, scalable, wireless, mesh network.** The Ideation, solar-powered PentaSense chipset measures physical properties of the five fundamental elements (water, air, fire, earth, and space) in order to assess risks from multiple hazards. Examples of measured data associated with hazards include soil moisture content for drought and wildfire, water surface elevation and discharge for flood, earth movement for landslide, and the lowest floor elevation of a building for flood.

Sensor device inputs are routed through Long Term Evolution (LTE)-, Long Range Wide Area Networ (LoRaWAN)-, cellular-, or satellite-based wireless protocols to a cloud server for processing. Optionally, for emergencies (e.g., flash floods), data are locally processed at the device level to provide real-time alarms and alerts. In addition, within the cloud, any applicable external data, such as USGS precipitation data and NWS storm predictions, are fused with direct-sensed data, which are then used as inputs for Federally approved or professionally peer-reviewed econometric models. When no traditional or published risk models



exist, we use artificial intelligence (AI)-based techniques, such as neural networks and machine learning, for calibration and validation purposes to conduct multi-variate, non-linear regression analysis. For example, when using ultrasonic sensors to measure water surface elevations, we fuse multiple sensor inputs that affect the speed of sound travelling from the sensor to the water, including ambient temperature and relative humidity, in a neural network algorithm to accurately calibrate the measurements (mean error ± 2 cm).

The Services

Ideation's Internet of Risk Meters Platform as a Service (IoRMPaaS) is a low-cost, hassle-free, easy- to-use, **end-to-end subscription service for a nominal monthly fee.** There are no fees for initial setup or equipment. The services provided as part of the IoRMPaaS include:

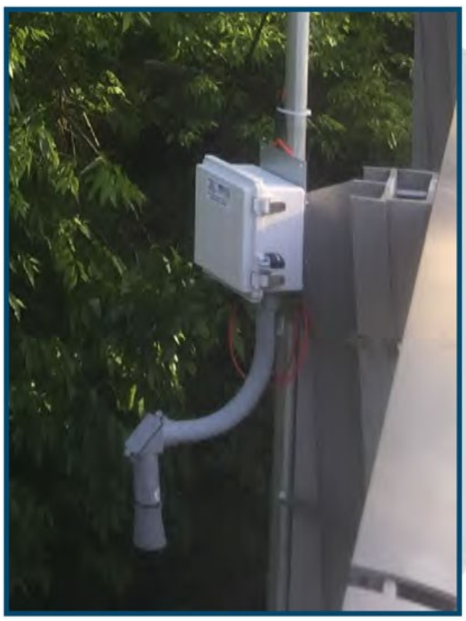
- Install, calibrate, and secure PentaSense devices
- Connect sensor devices to network
- Continuously (at user-configurable intervals) collect and transmit site-specific, telemetric data using state -of-the-art security standards
- Send alerts (based on user-configurable thresholds) to communities, first responders, and citizens
- Perform data analytics that conform to Federal requirements and industry standards
- Provide actionable risk estimates to communities, first responders, and citizens
- Provide secured access to cloud-based apps, analytical dashboards, and open standards-based APIs to extend risk modeling and monitoring
- Maintain hardware, including upgrades
- Maintain firmware, including updates
- These services enable communities to better prepare, respond and mitigate for future hazard events without having to worry about underlying risk estimation methodologies, technologies, and tools.

ideation
1768 Business Center Drive, Suite 230
Reston, VA 20190
www.ideationinc.com

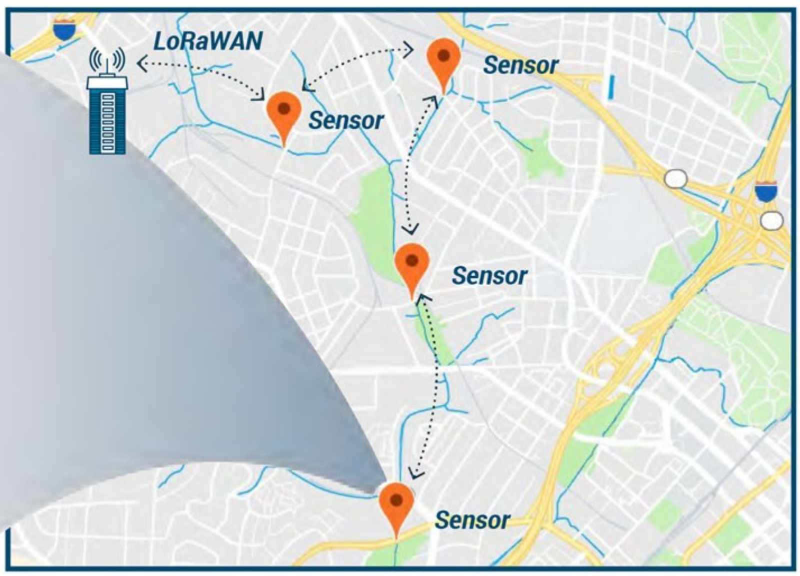
Example of an Implemented Use Case

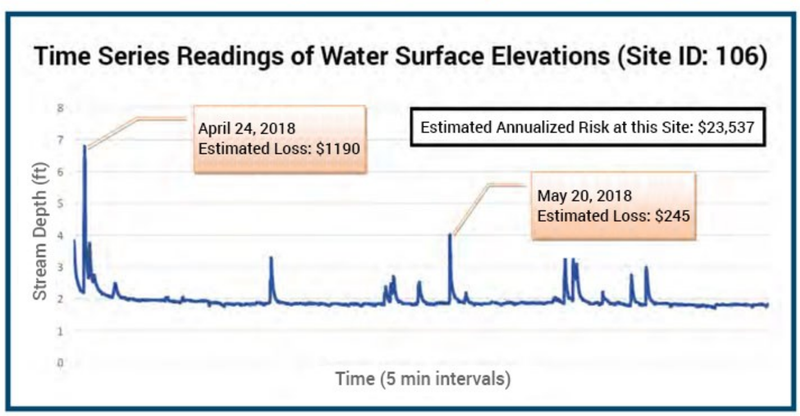
Ideation's IoRMP was used to calculate **economic losses for each flooding event as well as predict the future annualized losses** at bridges over streams due to road closures during flooding. Solar- powered, water surface elevation sensors were installed along county-wide streams in an urban area. The sensors were connected via wireless LTE and LoRaWAN gateway to a cloud server. Direct-sensed inputs such as water surface elevation data (at 1 cm precision), temperature, humidity, and battery level were collected. Stream depth data computed from Ideation's sensors were compared to stream depth data from co-located USGS sensors. Ideation's results were within ± 2 cm of the USGS results. After fusing external datasets, such as USGS streamflow properties and local traffic data, with the direct-sensed data, the potential economic losses for each flooding event of a road were estimated. For two flooding events occurring at one location, the estimated economic losses were $1,190 and $245. Also, future annualized risks at this location were calculated using a Federally approved econometric risk model. The future annualized risk was estimated to be $23,537.

Armed with these results, the county is now able to be better prepared for flash flood events, alert commuters of road closures, plan effectively for mitigation projects, prepare a well-documented grant application, and produce real-time flood inundation maps.



A field-deployed sensor on a bridge over a creek





ideation
1768 Business Center Drive, Suite 230
Reston, VA 20190
www.ideationinc.com