THE SAFECAST REPORT

VOLUME 3 - August, 2017

PART 1: THE SAFECAST PROJECT UPDATE

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This is the stand-alone version of Part 1 of The Safecast Report, 3rd edition, which was published on August 30, 2017. The first edition of the Safecast Report was published in March 2015, the second in March 2016. Both were opened to public feedback. The current edition integrates that feedback, and adds a significant number of new observations. Part 2 of the 2017 Safecast Report will also be initially published as stand-alone sections, follwed by a combined edition of the report. We extend our thanks to our many volunteers and supporters and strive to live up to your continued interest and support.

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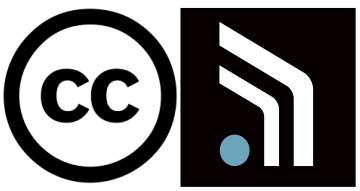
THE SAFECAST REPORT TEAM:

Azby Brown, Pieter Franken, Joe Moross, Nick Dolezal, Sean Bonner -August, 2017



www.safecast.org

With a disaster the size of Fukushima Daiichi, there is no way a single report could adequately reflect all viewpoints or answer all questions. The best we can do is to present a bird's eye view and point out where the landmarks seem to be. Concerned individuals must be prepared to inform themselves and seek their own answers. This report is intended to help people around the world to do that more effectively.

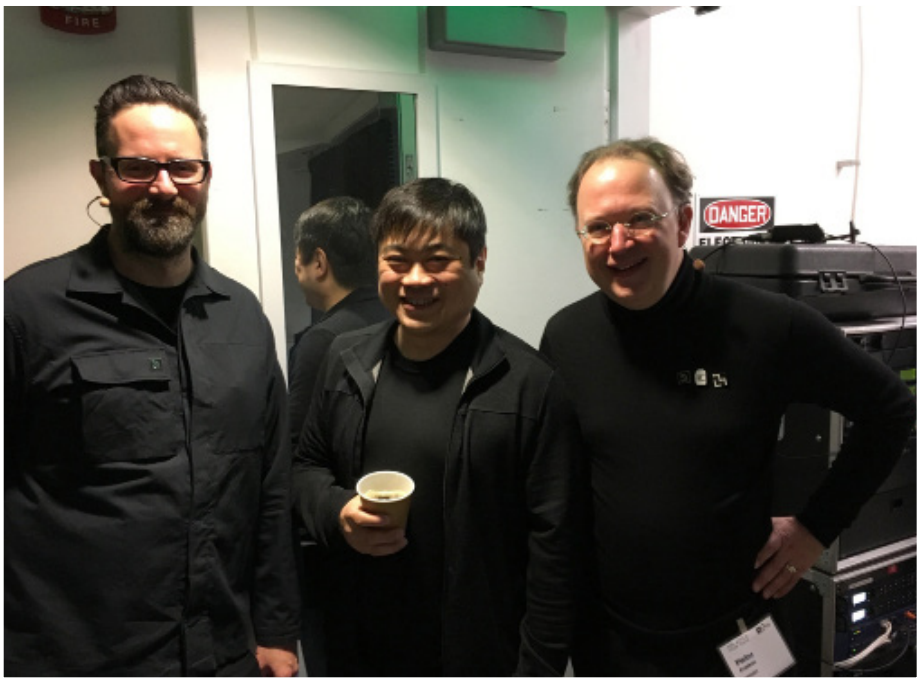
Top left: "Is Joe radioactive?" Mori Kids Summer workshop, Tokyo, Aug. 2016.

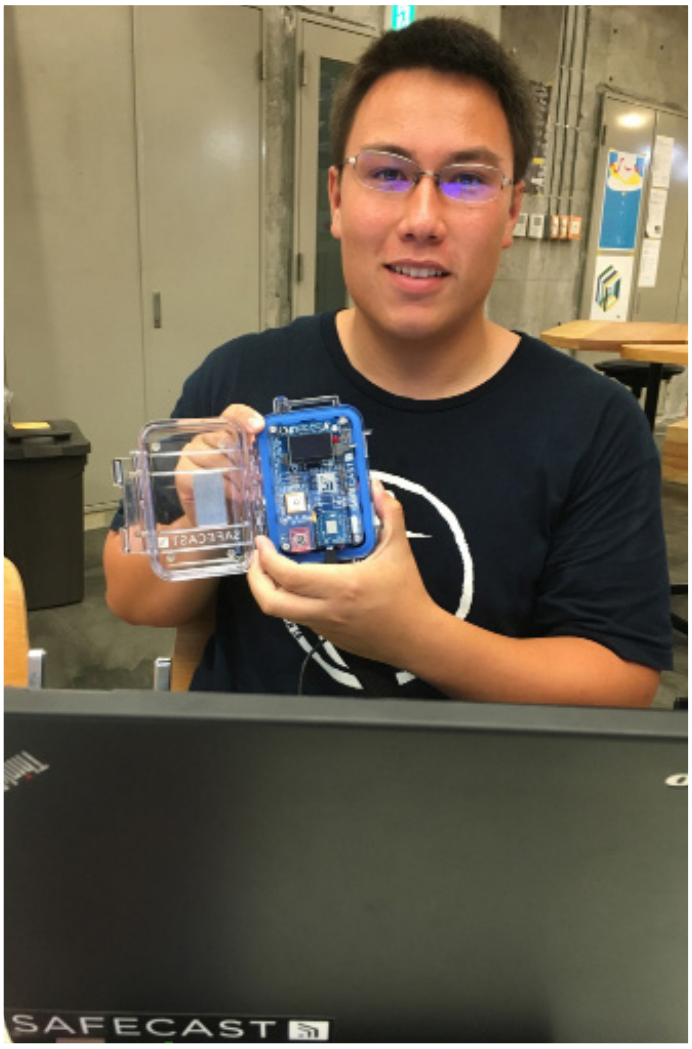
Top: ICTP workshop participants plesed with their first test of the bGeigie Nanos they built; Trieste, March 2017.

Left: The Safecast team meets data researchers from Penn State at the OWOD confence at MIT, April 2017.

Bottom left: Safecast co-founders Sean Bonner, Joi Ito, and Pieter Franken at the OWOD conference.

Botom right: Joe Moross speaks at the Japan Society of NY, May 2017.

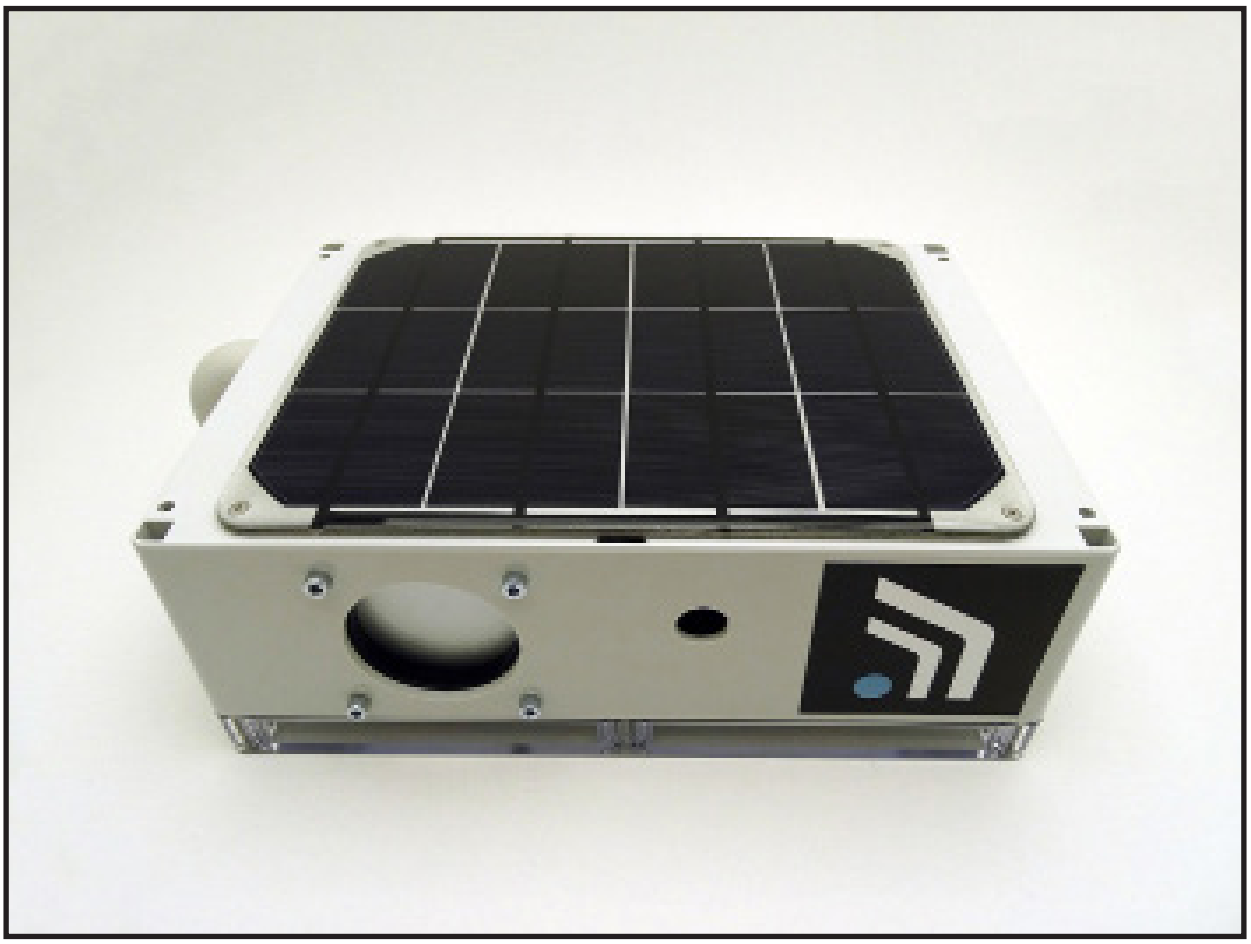




Top: Hope Makers from Hong Kong Maker Bay visited Safecast in Tokyo in June 2017.

Bottom left: 2017 Summer intern Kento Onikubo conducted hardware experiments and helped maintain Safecast devices at our office in Tokyo.

Bottom right: French university student Gael Alkan, France, visited the exclusion zone in Iitate Village as part of his data analysis project during his 2017 summer internship.



Prototype Safecast Solarcast combined radiation and air quality sensor system, introduced in 2017.

PART 1: THE SAFECAST PROJECT UPDATE August 2017

Compiled by Pieter Franken (Japan ops), Sean Bonner (Global ops), and Nick Dolezal (visualizations)

The Safecast Project now spans numerous aspects of environmental measurement. Key initiatives include:

» DRIVECAST - Mobile Radiation Measurement

» POINTCAST - Stationary Radiation and Air Quality Measurement

» SOLARCAST - Autonomous “Drop and Forget” Sensor System

» The Safecast API Data Backbone

» Mapping and Visualizations

» Applications

» Education and Training

» Outreach

» In addition, we will discuss Safecast principles and other developments:

» Openness

» The Safecast Code—what we stand for and how we (think) we do it

» Press & Publicity—highlights and coverage

» Organization and Funding

» Collectibles

» Always Improving

1.1 Safecast Code

The Safecast Code

In 2014 we published the Safecast Code 1.0, which attempts to describe the Safecast ethos through a list of 10 attitudes that guide our efforts. It can be considered our code of conduct, a guide that helps remind ourselves of our goals and helps us focus our efforts. We try to measure up to the values and attitudes embodied in this list and encourage others to do the same:

» ALWAYS OPEN – We strive to make everything we do transparent, public and accessible.

» ALWAYS IMPROVING -We can always do better so use agile, iterative design to ensure we're always refining our work.

» ALWAYS ENCOURAGING – We aim to be welcoming and inclusive, and push each other to keep trying.

» ALWAYS PUBLISHING - Results are useless behind closed doors, we try to put everything we're doing out to the world regularly.

» ALWAYS QUESTIONING – We don't have all the answers, and encourage continued learning and critical thinking.

» ALWAYS UNCOMPROMISING – Our commitment to our goals keeps us moving closer towards them.

» ALWAYS ON – Safecast doesn't sleep. We're aware and working somewhere around the world 24/7

» ALWAYS CREATING – Our mission doesn't have a completion date, we can always do more tomorrow.

» ALWAYS OBJECTIVE – Politics skews perception, we focus on the data and the questions it presents.

» ALWAYS INDEPENDENT - This speaks for itself.

These principles incorporate some of the guiding principles of Safecast co-founder Joi Ito <http://www.media.mit.edu/about/principles>. "Deploy or Die" and "The power of Pull" are two that resonate a lot with us.

1.2 Targets and Initiatives

As Safecast grows and matures, we have refined our targets and reshaped our activity into a number of interconnected initiatives. Many people know Safecast primarily because of the crowdsourced, citizen-science-based emergency radiation monitoring and mapping system we established in the weeks following the Fukushima Nuclear Powerplant disaster. Our radiation measurement initiative continues to grow globally, and still forms the major part of our activity. From the start, however, Safecast recognized that successful crowdsourced radiation measurement could provide a template for broader application of citizen-science principles to environmental monitoring, including air, water, and climate. Beyond this, we saw the opportunity to test the principles of openness and transparency, both through the use of open-source development and open data in the Safecast project itself, as well as by presenting our successes as evidence to help persuade others.

Safecast avoids rigidly structuring our organization or our activity, and our initiatives can be characterized as flexibly responsive and "emergent." We are cautious about identifying new initiatives, and only do so when the need has been demonstrated and a consensus appears. Our current primary initiatives involve environmental monitoring for radiation and air quality. These include the development and deployment of well-integrated Safecast-designed hardware and software, including maps and visualizations. These initiatives are marked by continual refinement and experimentation, and will be detailed below in the relevant sections. Our overall communication and outreach activities have gradually evolved into fairly discrete activity clusters. Education and training, primarily through workshops, have emerged as a major global initiative and are an important core competency of Safecast. Expert-oriented activities overlap somewhat with these, but can be considered a separate sphere of activity. Our growing status within the global expert community is largely due to the recognition we have achieved as effective objective communicators of controversial environmental issues, and recognition of the significance of our method of generating public interest and engagement. Our most notable activities in this regard will be noted below. In addition to our extensive social media presence, such as the Safecast Blog, exhibitions have also emerged as a notable component of our communication and outreach activity. Finally, we have initiatives intended to grow our active user community in Asia and in developing nations in Africa, the Near and Middle East, South and Central America, and the Caribbean. We have found the best way to do this is to hold workshops organized by locals, or to help organize training sessions with attendees from many countries.

In the following sections, the progress and development of Safecast's initiatives will be broken down into Hardware, Mapping and Visualizations, Applications, Education and Training, and Outreach (including expert-oriented activities, exhibitions, and others).

OPENNESS

As we have often stated, Safecast is pro-data (and its position is neither pro- nor anti-nuclear, or pro nor anti global warming). On most issues we intentionally take a non-political, nonpartisan stance. The single exception is on the need for openness and transparency of environmental data. The arena we have specifically chosen to engage in and seek to influence regarding the principle of openness is data about the environment.

We strongly feel that environmental data should be open, timely, easy to access, and easy to understand for everyone. Independent sources of environmental data must continually be available. In the age of the Internet of Things, citizens themselves can be the source of this essential information.

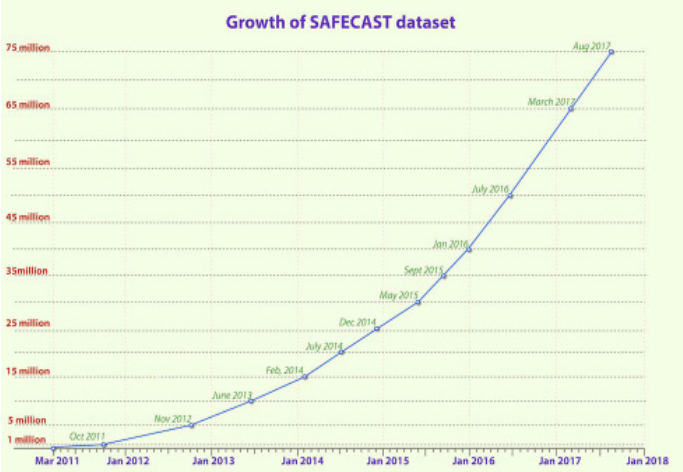
We believe that governments, research institutions, and companies should publish the data they possess about the environment into the public domain via the Creative Com-

mons (CC0) designation, and acknowledge the importance of third parties in validating their own data.

1.3 Hardware

Safecast hardware development is done in parallel with database/API and visualization U/I development. Though these components are closely integrated, we will discuss them separately, noting important connections as necessary. Safecast hardware systems include bGeigie mobile radiation measurement devices (under the “Drivecast” designation), fixed realtime radiation monitoring devices (under the “Pointcast” designation), prototype air-quality monitoring devices (also under the “Pointcast” designation), and a new category of combined radiation and air-quality monitoring device called “Solarcast” which combines features of our previous devices, but also solves issues encountered in ease of deployment.

1.3.1 DRIVECAST - Mobile Radiation Measurement



The Safecast radiation measurement dataset contains over 75 million measurements as of August 2017.

The Safecast radiation measurement dataset contains over 70 million measurements as of June 2017. Since April 2011, Safecast volunteers have been collecting radiation data using bGeigie mobile radiation sensors. As of June 2017 the size of the Safecast data set had grown beyond 70,000,000 measurements, adding over 20 million measurements over the past year alone, and currently adding 2,000,000 measurements monthly. Over 6 million of these measurements have come from fixed sensors, while the remainder is from bGeigies mobile detectors. While the number of people who have measured radiation as part of the Safecast project is many times more, there are over 1000 registered upload accounts, 49 of which have been used to log over 100,000 data points each, and 12 of which have been used to log over one million each. As we don’t keep count of the volunteers actually measuring (as many devices and upload accounts are shared) we roughly estimate the number of volunteers that have contributed data to be over around 3,000 since inception. The number of Safecast detectors deployed (fixed and mobile) is approximately 2000, including about 1500 bGeigie Nanos.

Almost all major Japanese roads have been measured, with many areas repeatedly measured over time, providing clear evidence of radiation level changes. Additionally, data has been collected from every continent and more than 80 countries, including most countries in Europe. The Safecast dataset includes data from far corners including Sudan, Iraq, and Antarctica, as well as sites of interest such as Chernobyl, Semipalatinsk, and the Marshall Islands.

A significant percentage of the growth of the data set continues to be from areas outside of Japan. Specifically noteworthy is the growth in Europe where Safecast has gained significant popularity and there is now a growing network of dedicated volunteers. Largely due to our Safecast Asia Network initiative, our volunteer communities in Taiwan, Hong Kong, and Korea are growing significantly. In addition, an important international expert workshop at the International Center for Theoretical Physics in Trieste, Italy, led to new data contributions from previously unsurveyed countries in Africa, Central and South America, the Caribbean, and the Near and Middle East. As has been the case in previous years, we have not yet seen much activity in Russia or the People’s Republic of China.

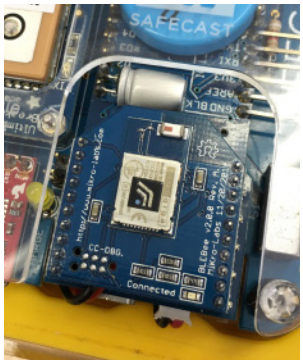
bGeigies:

The bGeigie Nano is the current workhorse of Safecast’s radiation measurement efforts.

bGeigie Nano

The bGeigie Nano continues to be the workhorse of Safecast’s radiation measurement efforts. Almost all of the data visible on our online map at safecast.org/tilemap/ was collected by volunteers using this unit. The Nano is a very stable device, easy to use, and affordable for committed volunteers including citizens, schools, companies, and researchers. Since it was released it in mid-2013, more than 1500 bGeigie Nano kits have been built. BGeigie models prior to the bGeigie Nano were much more labor intensive to build and had a higher individual cost per unit. Creating the

bGeigie Nano, scaled-down in both price and size and sold as a kit, solved Safecast's device availability problem almost overnight, allowing people from all over the world to easily become Safecast volunteers. This "crowd manufacturing" approach has proven very effective and efficient for fielding hundreds of self-funded devices in a short time. The bGeigie Nano has been professionally tested in labs in Japan, Germany and the US, and won the Good Design award in 2013.



.BLEbee interface module

In 2015 the bGeigie Nano was extended with a Bluetooth interface that allows iOS and Android devices to connect and facilitate measurement and upload while on the go. BGeigie Nanos are available with or without the BLE interface, and it can easily be added later. The bGeigie Nano kit is available globally and sold through our distribution partner kithub.cc, and available in the US, Europe and Japan on Amazon.

The bGeigie Nano is a very stable platform, but we continue to make small revisions, most of which simplifications which make it easier to build but do not change the unit's functionality. These are reflected in minor revs to the mainboard, and include larger solder pads, and changes to some component locations to make them easier to solder. In addition, changes were made to allow the Nano to use OLED displays from a different manufacturer.

NEW HARDWARE: bGeigie Raku:

As described above, the bGeigie Nano is the current workhorse of the Safecast radiation monitoring system, with over 1500 units sold as kits and in use worldwide. However, the time and skill required to build the Nano kit, including soldering, has made some people who want to participate hesitate to make the commitment. This has particularly been the case with younger and senior volunteers. As our community continues to grow, we've recognized the need for something even simpler, to enable more people to participate.

The next-generation bGeigie Raku is our solution. Raku stand for "easy" in Japanese. The new bGeigie Raku shares the form factor of the award-winning bGeigie Nano, but is entirely updated for more power and ease of assembly. Like the bBeigie Nano, it's a kit, but adopts a pre-assembled main board and plug/snap together components and housing to make it possible to assemble it without soldering. Besides being easy to build, it also brings other improvements, such as (1) easy to read (2) easy to hack (3) easy to upload and (4) easy to configure.. Like the bGeigie Nano, it is easy to hack and expand especially as it has a faster CPU and more available memory than Nano while remaining Arduino-compatible. It has a larger, easy to read display, and settings are easy to configure with a joystick controller, eliminating the need for editing config files. On-board Bluetooth BLE make uploading data through iOS and Android devices easier as no SD card reader is needed.

Our first prototypes are very promising, and we expect to produce the first 50 Raku units by early 2018.

The bGeigie Raku

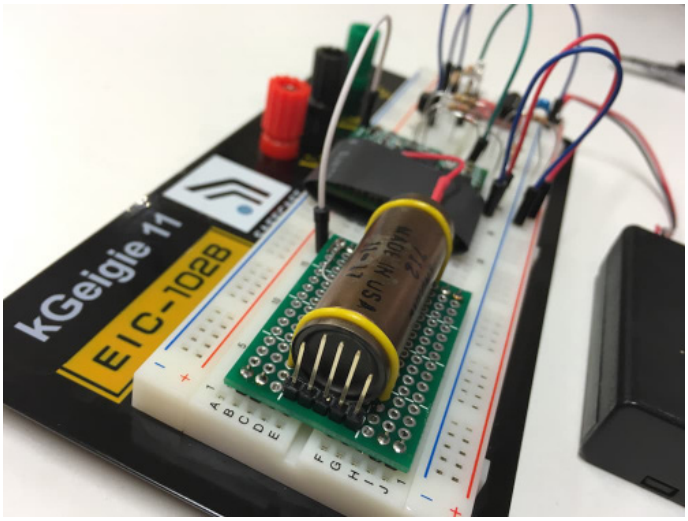
Earlier bGeigies in use in the field:

Previous incarnations of the bGeigie included the three original suitcase-size bGeigie "Classic," the bGeigie Mini, bGeigie Plus, bGeigie Stealth, and the a one-of-a-kind special deployment xGeigie. We also designed, prototyped, but ultimately abandoned a bGeigie 3. Of these, some units are in use by volunteers in the field including by our corporate partner GLC, and Japan Post in Fukushima for our Street-by-Street program (see below). With these exceptions, all other mobile Safecast data is currently being gathered using bGeigie nano units.

Street-by-Street Local Government Measurement Program

In 2012 we initiated the Street-by-Street program to work with municipalities in Fukushima to measure entire cities road by road. The participating municipalities welcome the opportunity to provide independent radiation survey information to their citizens to supplement the information available from the government. Three cities in Fukushima (Minamisoma, Koriyama, Tamura) were measured under the Street-by-Street program in 2012 and 2013 and a new third round of surveys is currently underway.

kGeigie/eGeigie



The education-oriented kGeigie (aka eGeigie)

In 2015 we developed a simple educational Geiger-counter kit, which we called originally called the kGeigie (Kid's Geigie or Kodomo Geigie), that can be built in about an hour by elementary-school children or really anyone older than that. It proved extremely successful, and we received a number of subsequent request to hold similar educational workshops for this age group. In primarily english speaking regions this is referred to as the eGeigie (Educational Geigie). This kit can be assembled and disassembled, making it easy to reuse. It has been steadily refined based on our experience teaching children how to build it.Fixed sensor transform kit

Pocketcast

Pocketcast prototype

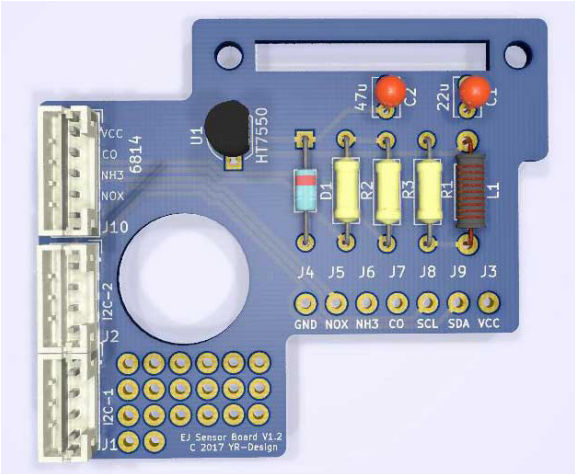
Pocketcast is a compact radiation detector that connects seamlessly with mobile devices and can run for extended periods without the need for recharging. The prototype was developed during the Safecast Conference Hackathon in 2015. It's a promising device but has not yet been developed further.

Fixed sensor transformation kit

A number of volunteers have expressed an interest in being able to convert this device into a static realtime sensor so it can collect data at home or the office when it's not being used to collect mobile data. A transformation kit is under development which uses an additional board that can be plugged into the XBEE header on existing bGeigie Nanos, allowing them to collect continuous data from a static location and automatically upload the readings. Both hard-wired (ethernet) and wireless (wifi and Bluetooth) options are planned.

Fukushima Wheel

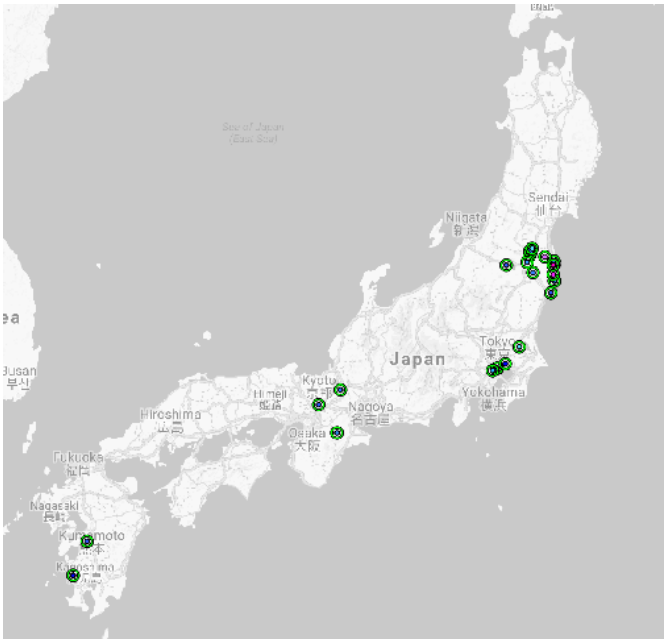
Fukushima Wheel (credit: Eyes Japan)



New daughter board for the Fukushima-Wheel modified bGeigie nano, to enable the use of modular gas sensor.

This ongoing project is being developed by Eyes Japan in conjunction with the University of Aizu, in Aizu Wakamatsu, Fukushima, under the guidance of CEO Jun Yamadera. A custom-designed rental bicycle is fitted with sensors and wireless, and can show location-based advertisement on the wheel through a LED display system mounted on the wheels; this combines environmental measurement with a local business model. The second generation of the Fukushima Wheel uses modified bGeigieNano that includes sensors for carbon monoxide (CO), nitrogen dioxide (NO2) and ammonia (NH3), temperature, and humidity. A third generation prototype which included PM2.5 and UV sensors. The system is now being extended with firmware that will be able to display carbon monoxide (CO), nitrogen dioxide (NO2), ethanol (C2H5OH), hydrogen (H2), ammonia (NH3), methane (CH4), propane (C3H8), iso-butane (C4H10) when the appropriate sensor modules are installed.

1.3.2 POINTCAST - Stationary Radiation Measurement



Safecast has deployed a network of fixed realtime sensors.

IIn March 2015 Safecast launched a fixed realtime sensor network called "Pointcast." Prior to this, in 2011, Safecast together with Keio built a network of over 300 fixed radiation monitors under the sponsorship of Softbank. This network was in operation for over 4 years and has now been retired. We also deployed a number of networked fixed sensors called the nGeigie (Network Geiger) that become the direct inspiration for the Pointcast. The Pointcast system represents an upgrading of capabilities in terms of hardware, software, and communication, and also reflects lessons learned regarding our community. It is called "Pointcast" because data is collected at a single geographical point, as opposed to mobile data gathering using bGeigies under the "Drivecast" designation. Pointcast radiation sensors send realtime updates about radiation levels and publish it online directly at pointcast.safecast.org without interceptions or filtering. This data is also displayed on our main web map at http://safecast.org/tilemap/. It is openly available for download or reuse through a CC-0 license. The first series of Pointcast sensors was for radiation, but a number of Pointcast fixed air quality measurement devices have also been deployed and tested (see below).

At present, 45 Pointcast radiation sensor units have been deployed globally. Of these, 26 are in Japan, and 16 of those are in Fukushima, and are intended to help detect releases from the Daiichi plant (Pointcast is the only independent realtime radiation monitoring system currently in place in Fukushima and Japan). The United States has 16 Pointcast units, most of them on the East Coast. In addition, Taiwan, Hong Kong, and Switzerland have one each. Several more deployments are being scheduled. Informative blog posts describing the Pointcast system in detail are at accessible at https://blog.safecast.org/2016/05/pointcast-rollout-part-1/ and https://blog.safecast.org/2016/07/pointcast-rollout-part-2-iitate-village/

The Pointcast devices are more expensive than the bGeigie Nano and the program is dependent on volunteers who are willing to support the initiative, to cover the cost of the hardware as well as provide a hosting location. A large portion of the funding for this system has come from the Shuttleworth Foundation, and the Japan Society of New York funded several additional units. Other supporters include Soracom, Digital Garage, Aoyama Gakuin, and a number of individuals.

Pointcast hardware elements: Top: Medcom Hawk detector; Bottom: Pointcast control and communication unit.

Pointcast sensor stations are comprised of a sensor module and a communication module. A number of earlier nGeigie installations which used a single pancake Geiger-muller tube sensor were integrated into the Pointcast system, but the majority use the Medcom Hawk Radius detector unit. This is a reliable unit that has been in production for the past 25 years, manufactured by our close supporter International Medcom. This sensor module contains two Geiger-muller tubes—one that measures the dose rate equivalent in uSv/h and one "pancake" tube, similar to those in the bGeigie, to measure the combined alpha, beta, and gamma activity in

counts per minute (CPM). Pointcast sensor modules are installed outdoors, while the communication module is generally located indoors, connected by a cable. The indoor module has a clear display showing the levels measured outside and has an alarm function to warn in case of a sudden increase.

Pointcast communications modules can be configured to use either a wired ethernet LAN connection or 3G wireless. They require external power. Initially we expected that most deployment sites would use a fixed ethernet connection. In Japan, however, many people have abandoned fixed phone lines and fixed internet access altogether, and exclusively rely on mobile phones for internet access. Few locations available to us in the Fukushima exclusion zone have fixed internet access either. To make deployment less dependent on the communication infrastructure available onsite, we decided to provide focus more on 3G-capable Pointcast devices. Low-cost data-only 3G SIM cards became increasingly available since 2015, and Soracom.com, a Japanese startup mobile provider, has lent considerable support to the project. The majority of Pointcasts deployed since the summer of 2016 have been 3G-enabled.

The online visualizations of Pointcast radiation data include a icon-based data layer on Safecast's interactive maps which indicate each sensor's operational status and radiation level at a glance, and give access to click-through time-series graphs showing changes over the past month. Easy access is also provided to more detailed information about each specific sensor. See section 1.4 Mapping and Visualizations below, and https://blog.safecast.org/2016/05/pointcast-rollout-part-1/ for more information about these features and recent updates.

The Pointcast system has already covered two major events (1) The 2016 tsunami hitting Daiichi and (2) Forest fires near Daiichi (ADD LINKS). Both events pulled much attention to Safecast covering these with realtime radiation updates from the Pointcast sensors and shown that there's a big "pull" for our data under times of crisis.

The Pointcast hardware system has been relatively reliable and trouble-free. Safecast soon recognized the need, however, for more fully "drop and forget" devices, where citizens do not have to bother with installation, especially pulling cables from indoor to outdoors. Since 2016 we have has developed and deployed an entirely new system called "Solarcast," described below, which builds on the experience from deployment of the Pointcast sensors.

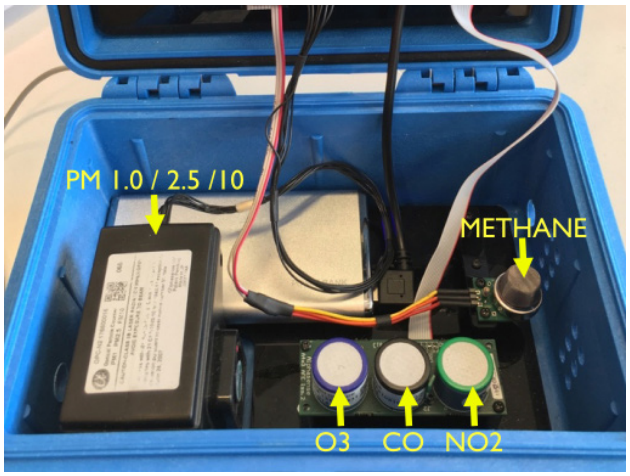
1.3.3 POINTCAST - Stationary Air Quality Measurement

While the initial focus of Safecast was radiation measurement, which remains our major activity, from the beginning we realized that many other aspects of environmental monitoring could be tackled using an open-source citizen science approach. As early as 2012 we began experimenting with air-quality monitoring systems, and have developed and tested several prototype devices under the designation "Safecast Air." Since 2016 we have taken several large steps towards wide-scale deployment of networked air quality measurement devices, culminating in the first generation production run of Solarcast, which includes both air-quality and radiation detectors (see below).

An important note here is that there is no accepted definition of what "air quality" is, and it's therefore safe to assume that any discussions about air quality are vague, generalized, and likely referring to different measurements of various things. Because of this lack of common understanding we're uncomfortable with the term "Air Quality" however there is no better alternative at this point so we've continued to use it.

As we've frequently stated, air quality is harder to measure than radiation. Unlike radiation where there is a clear consensus about which sensors are reliable for specific applications, air sensors are much more diverse and tend to be less reliable in general. The combination of commercial and governmental disagreement about what should be measured and how, as well as a lack of industry wide standards and definitions makes this even more challenging. While radiation measurement is a largely settled and agreed upon topic, air quality monitoring is changing almost mostly which makes sensors deployed even last year obsolete today. We've spent a significant amount of time and money trying to find and calibrate sensors that produce consistent measurements, have debated the value of what we should be measuring and have tested a variety of form factors and deployment modes.

Safecast Air Quality prototypes



Safecast prototype 002 air quality sensor.

At SCC2015 we announced a modular Safecast Air Quality prototype. This design used a central core and allowed various different sensors to be added for different testing and deployments. As part of these tests, we've collaborated with SCAQMD, EDF, NRDC, MIT Media Lab, and Google among others. Particulate pollution, specifically PM2.5, is of global interest and methane, a core greenhouse gas, is an important gas to quantify when considering climate issues. In early 2016 we documented a number of working Safecast Air Quality prototypes which we had deployed for testing:

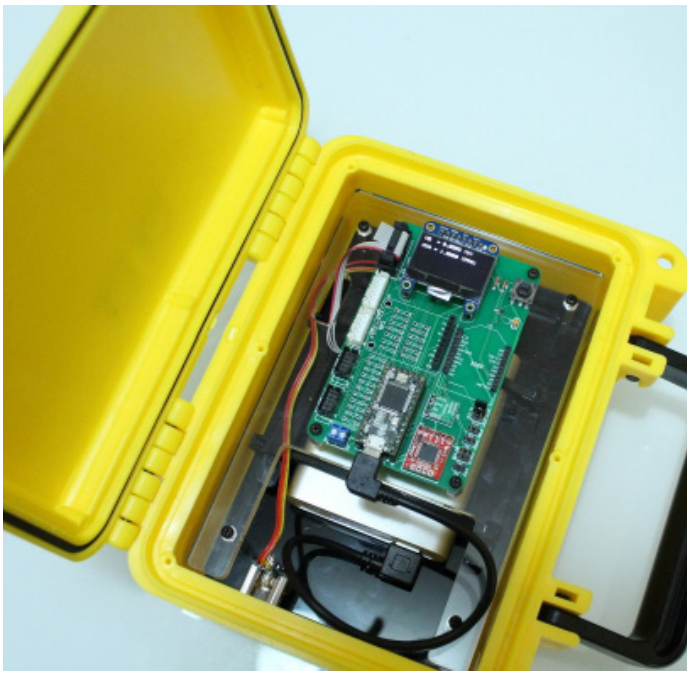
» Prototype 001: Included sensors for particulate (in PM10, PM2.5 and PM1.0) as well as a bank of 6 high end gas sensors, generally tested to measure 3 gases, with 2 sensors for each. It had a large enclosure for ease of access and reconfiguration and reused much of the bGeigie Nano board design, but had a more powerful CPU and

expanded IO capabilities

» Prototype 002: Also designed as a static sensor, but almost 75% smaller than Prototype 001 and hence much more portable. Internally it had the same sensor configuration however it used smaller mid-range sensors.

» Prototype 003: A very mobile, purpose-specific device equipped to measure methane only, in response to the Porter Ranch Gas Leak outside Los Angeles.

https://blog.safecast.org/2016/01/safecast-air-prototypes/



Safecast prototype 003 air quality sensor, for methane

Air Quality Beta Kit

Performance tests of the Safecast Air Quality prototypes led to the decision to produce Air Quality Beta Kits, to enable us to see how the platform performs in real use and to learn more about the data the sensors produce, to fine tune the design of the units and the calibration of the sensors. These kits were distributed by kithub.cc, and were designed to measure airborne particulate matter in PM10, PM2.5 and PM1.0 sizes. They log temperature and humidity for calibration purposes, and are intended for static installation in a single outdoors location for at least 3 months. About 20 kits were sold, and most (but not all) were built and installed, sending data from locations in the US, Europe, Australia, and Mongolia. As this was a beta release, the data collected was published into the public domain under CC0 but is considered test data only, and not scientific or research grade. As the test was specifically designed to explore longer term deployment of the hardware and resulting data, rather than any consistent environmental area there was not strict control on how the devices were to be deployed other than that they should be outside. Consequently it will not be included in the official Safecast dataset. We are exploring the possibility that these beta devices may be upgraded to production versions in the future, but currently have no specific plans for this.

Complete information about the Air Quality Beta Kit is available here: https://kithub.cc/safecast-air-quality-monitoring/

An example of the data produced by one of these devices can be seen here:

http://dev.safecast.org/en-US/devices/50011/measurements?order=captured_at+desc

Features of the Air Quality Beta Kit include:

» Designated header for the Alphasense Particulate Monitor (OPC-N2)

» On-board temperature/humidity sensor

» On-board GPS for location data (similar to the Safecast radiation sensor)

» On-board WiFi for sending real-time data to Safecast server

» Based on Teensy 3.x development board

» SD card (OpenLog) for data storage

» LCD display

The Safecast Air board is an Open Source Hardware project. KiCad design files for the PCB can be found on Github: https://github.com/Safecast/Safecast-Air.

The configurable air quality measurement board can be expanded to include other gas measurements.

Two designated headers are provided for using up to six Alphasense 4-electrode gas sensors (both A4 and/or B4 types), and a UEXT expansion header for connecting other additional sensors or other hardware.

1.3.4 SOLARCAST - Autonomous “drop and forget” sensor system

First-generation Solarcast prototype

Concept

As mentioned above, with the deployment of our Pointcast

network we realized that a recurring problem with placing sensors in the field was that we could not assume that power and wired internet access would always be available in the desired locations. We also found that an experienced Safecast team member to be physically involved with each installation, which slowed deployment. Our bGeigie experience proved that the easier we make the process of getting data from the device to our database, the more data will be collected. This sparked discussions about design parameters which would overcome these problems while providing the option to include air quality and other sensors. In effect we rethought the stationary sensor platform problem from square one.

We concluded that what was needed was a totally wireless, self powered, auto-configuring device that could be dropped anywhere and forgotten. Because we wanted this to be very simple, we initially called the project “Simplecast.” Eventually we realized that the independent power aspect was the most significant technical challenge, and dubbed it “Solarcast.” The first generation of Solarcast units combine what we’ve learned deploying bGeigie mobile radiation sensors, Pointcast fixed radiation sensors, and Safecast Air devices, and provide convenient, independent, “drop and forget” operation. Future Solarcast devices may have different sensor configurations.

Original Safecast team member Ray Ozzie took the lead on all aspects of this project, embracing challenge to meet the self-prescribed requirements. We decided on dual pancake GM sensors, similar to the Pointcast systems, and dual air particulate sensors of different classes (a higher end sensor produced by UK company Alphasense and a lower end sensor produced by Chinese company Plantower) that could validate each other and provide useful real-world data for future devices and deployments. Initially Ray called it the Simplecast (for simplified deployment) but as it prominently featured a solar panel it later became the Solarcast!

We documented Solarcast on our blog: https://blog.safecast.org/2017/04/introducing-solarcast/

https://blog.safecast.org/2017/05/solarcast-behind-the-music/

Solarcast prototype in typical deployment mode at MIT Media Lab

Main features:

» Drop and forget: Solarcast is compact, portable, and independent. It can easily be deployed almost anywhere, and includes a theft-deterrent security ring

» Self-configuring: Automatically identifies and utilizes available communication methods (LoRa or 3G Cellular)

» Low-power consumption: Energy usage has been optimized to provide unattended operation using solar-charged battery power, using dynamic power-adaptive sensor sampling scheduling algorithms. The device can run for over 10 days on a full charge with no sunlight, which in turn allows it to run indefinitely with only a few hours of direct sunlight each day.

» Combined radiation and particulate: Dual radiation sensors and dual particulate sensors enhance reliability and data density as well as providing useful data about the sensors themselves.

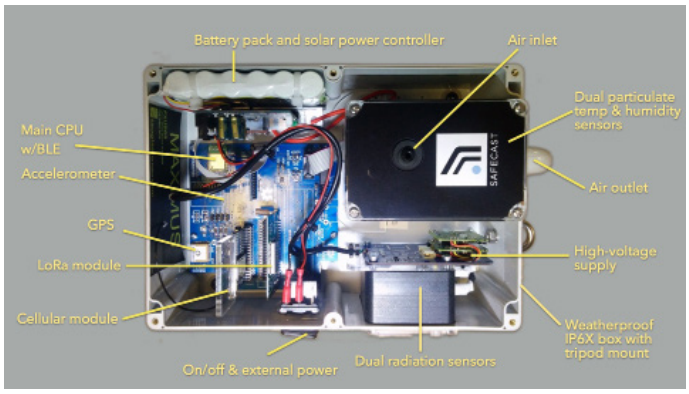
» Rugged: Designed for long-term outdoor use

» Safecast-integrated: Automatically uploads data to AWS-based service for data validation and database ingestion

» Remote configuration and monitoring: Slack-based remote performance monitoring, parameter configuration, firmware updates

Thanks to support from The Shuttleworth Foundation and Annenberg Foundation and built by our friends at Fabrikor in Slovenia, these devices are being deployed primariy in and around Los Angeles, with additional coverage locations across the US, Europe, and Japan.

Sensors:



Solarcast system components

» Air: Each Solarcast unit has an enclosed particulate sensor module which contains an Alphasense OPC-N2 and a Plantower 5003 particulate sensors, measuring PM10, PM2.5 & PM1.0.

In addition, the units have interior and exterior temperature and humidity sensors, both for calibration and performance monitoring.

» Radiation: Dual LND 7317 2” pancake GM tubes (same as in the bGeigie and Pointcast units) with Medcom iRover high voltage power supplies

» Comms: 3G cellular* or LoRa**, with communications modules selected as appropriate for use in most locations worldwide

» Position: GPS; Accelerometer (for detection of movement to cause GPS to be resampled)

» Power: Solar panel and battery pack (trickle-charged by the solar panel), with integrated voltage and current sensors permitting remote performance monitoring

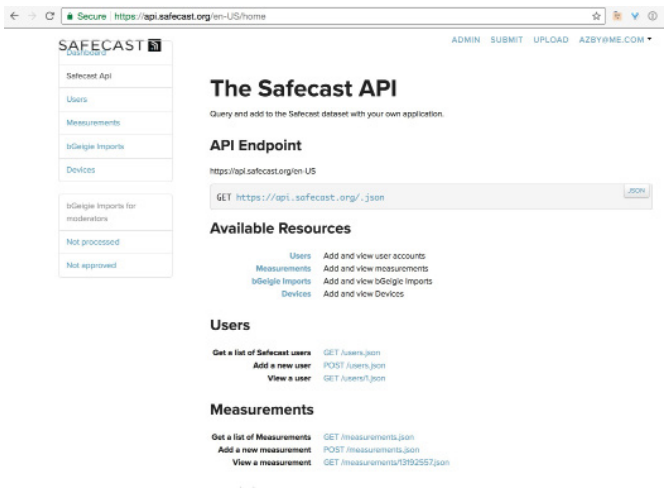
**3G cellular data connectivity is pre-provisioned using an integrated AT&T or Soracom SIM managed by Safecast*

***The Solarcast is LoRa capable, and can use any existing LoRa or LoRaWAN gateway it detects. We've designed an optional compact LoRa gateway that can be used in cases where none are available and that option is preferable. The gateway requires external power and LAN connection, either hard-wired or WiFi. LoRa has a range of up to 20km outdoors; indoors the signal can penetrate concrete walls at the expense of distance (i.e. there is a tradeoff between distance and penetration). It can be useful in situations where cellular connection is poor or not ideal.*

Status
An initial run of 30 Solarcast units were produced at Fabrikor in Slovenia in 2017 (http://fabrikor.eu). These are gradually being brought online in test deployments in the US, Europe, and Japan.

Visualizations
As mentioned above, air quality data, even when limited to particulate, is more complicated to measure and visualize than radiation data. A separate database and visualization system that works well with our radiation API and visualization system was developed and is currently being tested. (see below) We intend to include measurements from the Solarcast systems on our primary web map. Those visualizations are currently running in test form on a separate instance of the online map.

1.4 The Safecast API



Safecast API access page

The Safecast API is our core asset and is the focus of great deal of continuous development work by diligent team members scattered across the globe. The API provides a means for structured access to the Safecast database, and is the means by which data is uploaded, managed, and visualized. In short, the API is Safecast Data Grand Central, and nothing happens without it. It is a constantly improving work in progress, and we've learned a lot about scaling and reliability, about user-centered design thinking, and future-oriented planning. Even though it is the essential core of our entire data system, from the point of view of users who upload data or interact with our maps, it is the largely invisible "back end."

The Safecast API is a key example of our approach to openness. In addition to our data itself, which is downloadable and useable for any purpose no permission required, all of our API code and documentation is openly available. Making everything openly available makes it easy for technically knowledgeable people to investigate our data and test its trustworthiness, and encourages many people to participate. We designed our system and our openness policies with demanding people and skeptics in mind. We wish this were the case for everyone publishing independent radiation data (or any data, for that matter), but it's not. There's no reason for the public to consider "independent" data more trustworthy than "official" data unless the people publishing it can demonstrate that it's technically comparable and also more transparent and free of possible bias. We encourage others to start with the assumption that their data cannot be considered trustworthy unless it can be easily and anonymously accessed by others and put to demanding analytical tests.

"Openness" is not something that can be easily added later, but needs to be integrated into the data collection system from the start, including ensuring that there's a consensus among all the participants that it's a major priority. An open system doesn't have to cost more than one that's not, but it does require careful consideration and planning.

This detailed FAQ about our openness and data access features remains relevant:

http://blog.safecast.org/faq/openness-and-data-access/

Many improvements have been made to the API in order to implement new features on our web maps, and these will be described in the next section. Many other "backend" improvements have been made that will not be apparent to most users. The most significant of these are related to the Solarcast project. The Solarcast units each produce two streams of particulate measurement data as well as two streams of radiation data, in addition to temperature, humidity, GPS, and accelerometer data. We felt it was necessary to process and manage this data as independently as possible while allowing it to be visualized on our existing maps (see below). We dubbed these data streams "ingest" to differentiate them from our standard radiation data, and in-house that term has come to refer to the entire system. The primary API developments connected with this are:

1. New database backend and API ingest system for Solarcast data streams.

2. New data processing, aggregation and output of ingest/Solarcast data streams.

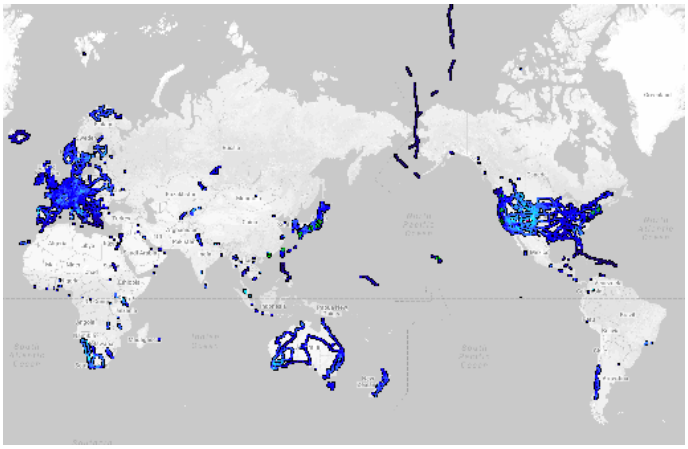
Use of AI, Distributed database and Blockchain for next gen API

Parallel to the single database, currently the curation of the Safecast database relies on volunteers checking and vetting the data that comes in. This vetting takes time (typically 24 hours or so) , inserting a delay and creating a single point of failure. Recent breakthroughs in artificial intelligence are present the possibility of automating processes like these, at least to some degree. Technologies such as bayesdb, a statistical database technology created at MIT, are currently being evaluated for identify outliers in our database, for instance.

One of the challenges of a central database is how to guard it against single points of failure. We are currently investigating the potential of a distributed data architecture for hosting data independent of a single instance.

Blockchain is a relative new technology that allows data to be validated without the need for a central authority. There are many parallels between the concept of blockchain and the way Safecast builds trust into its data. In essence, Safecast volunteers are assumed to largely not know each other, and consequently not to possess personal trust relationships. They measure the same locations independently, however. In actuality, these redundant measurements form the basis of a trust structure, in that measurements are automatically and continuously cross-vetted against each other. This creates the trust in the data, as long as participating volunteers keep their independence. Blockchain technologies use a similar network of parties that operate independently to create a trusted chain of transactions (typically the transactions are written to a distributed ledger, open for all participants to see). The idea of a distributed ledger is a promising direction for keeping Safecast data safe in terms of provenance (e.g. data measured cannot be changed later) and maintaining the data history across a distributed network (e.g. a single entity can't delete our history). We are very enthusiastic about these possibilities, which could play an important role in easing the scaling of our dataset to the next level. In 2017 discussions have been started with MIT Media Lab (Boston USA) and Keio University Block Chain lab (Tokyo, Japan) to experiment with the Safecast dataset and various blockchain based technologies.

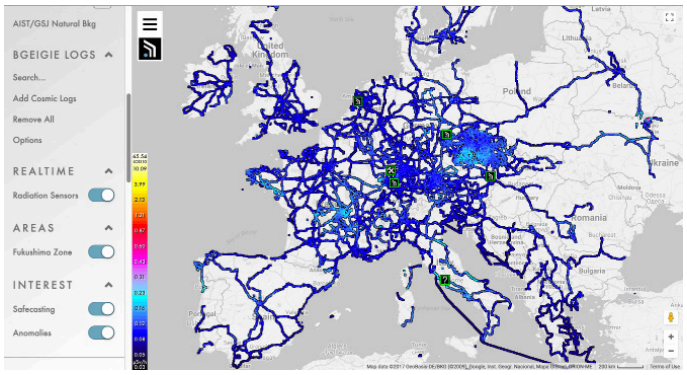
1.5 Mapping and Visualizations



Safecast's online tilemap is updated with user-submitted data several times daily

When creating maps for public use, our goal is to provide visualizations of the data we collect that are accessible and easily understood without compromising detail or accuracy. Safecast's data visualizations include the Safecast web map (http://map.safecast.org/), maps and graphs specifically for the Pointcast system (http://realtime.safecast.org/map/), and several apps for iOS and Android. These are discussed in the relevant sections below.

Online Maps



New features are regularly added to the online tilemap to enhance the user-customizable data display.

Perhaps our most accessible visualization is the Safecast web map, also known as the Safecast tilemap (because the displayed datapoints are rendered as frequently updated image tiles to speed performance). Safecast has experimented with, developed, and published a number of versions of radiation data maps, beginning with simple Google Fusion maps in 2011 (http://www.majiroxnews.com/2011/08/11/safecast-launches-map-with-500000-radiation-measurements/), a more useful and informative system called GeoSense released in June 2012 (https://blog.safecast.org/2012/06/major-map-update/), and, when that was outgrown, our current tilemap platform, developed and maintained by Nick Dolezal, in May 2014 (https://blog.safecast.org/2014/05/updated-safecast-webmap/). This visualization platform has proven to be extremely robust and scaleable. It's flexibility and extensibility have allowed Safecast to use it as a convenient single point of access for all of our data. It is highly customizable, with a many independently selectable data layers, underlay maps, notations, and display features. A major update was released in Sept 2016, and a version that displays Solarcast air quality data has been running in test mode for several months and is expected to be released to the public soon. Our blog post announcing the Sept 2016 update contains a detailed description of features and UI controls: https://blog.safecast.org/2016/09/safecast-web-map-update/

Major Map U/I improvements since the Sept 2016 update:

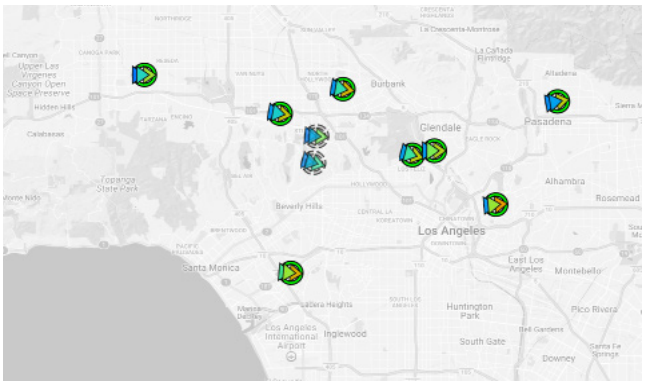
1. Spanish and Portuguese languages were added to the multilingual web map menu UI.
2. New web map layers were added to link to relevant Safecast blog articles and display notes about anomalies.

3. The bGeigie Log Viewer has been integrated with the existing Safecast API site, and a number of enhancements for log file moderation and review were added.

4. The Safecast “snapshot” 6-month time period layers have been updated and regenerated.

5. A new web map layer, graphs and dynamic icons for ingest/Solarcast air quality data has been added (currently in a test deployment only), as well as provision for visualizing Solarcast realtime radiation data.

SOLARCAST visualizations



Solarcast air quality data visualizations are being tested in experimental mode prior to open release.

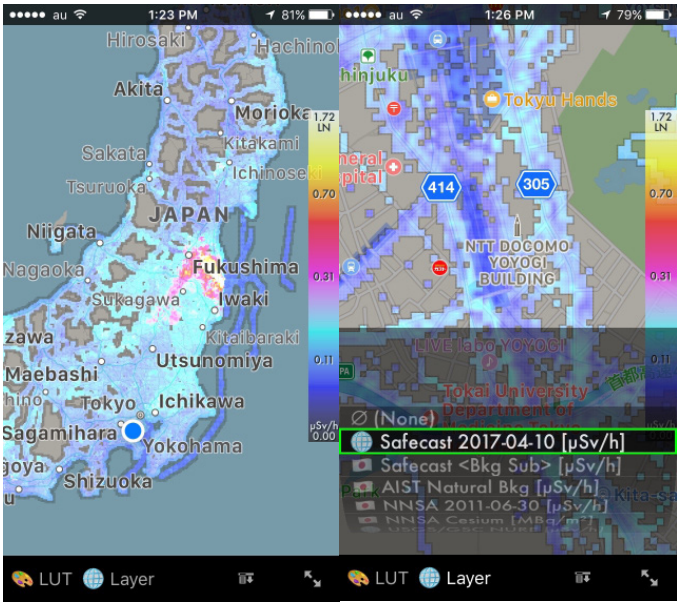
As described above, our new Solarcast hardware platform marks a great departure from our previous data-gathering systems. It adds dual particulate air quality sensors, which requires a different kind of visualization than radiation does. Like our Pointcast realtime radiation monitoring system, it must be able to show changes over time. The radiation data streamed by Solarcast is similar in most respects to Pointcast, and can similarly visualized in most respects. But unlike Pointcast units, which are expected to remain in the same location for years, Solarcast is designed to be re-deployable, which presents a challenges regarding the geographic continuity of the data. And, as noted above, Solarcast also provides data on temperature and humidity, as well as battery charge level.

A lot of the development effort on Solarcast visualizations to date has been backend-oriented, ensuring that the data flow is working properly. We have developed a simple dashboard for displaying all the data for each device, and have begun to refine the UI and graphic displays. As always, our end goal is to make it possible for users to intuitively grasp the measured levels at a glance, and to provide them with simple means for displaying more detailed information. The test version of the safecast tilemap that includes a toggleable Solarcast data layer can be seen here: http://safecast.org/tilemap/test2

1.6 Applications

To date four mobile applications have been developed by volunteers and released free of charge. These include three for iOS and one for Android. These apps provide different functions, such as access to Safecast radiation data and Bluetooth-based bGeigie Nano upload capability via smartphones.

iOS Safecast Map App



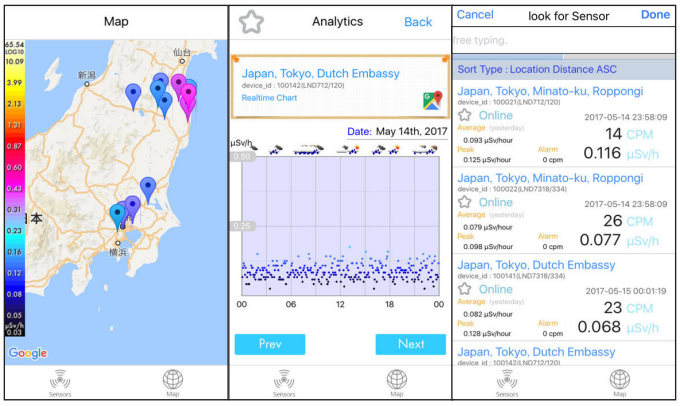
The Safecast iOS app provides a full-featured display of Safecast map data, with many user-customzable features.

This originated as a custom version of the Geiger Bot app by Nick Dolezal. It includes the entire Safecast radiation dataset, as well as tools and features for taking radiation measurements with a variety of devices. In addition to the full Safecast dataset, it includes data from the US DOE/NNSA, USGS and Canadian Geological Survey, US EPA, and others.

Current version: 1.7.1 (last updated: Mar 22, 2014); Requires iOS 6.0 or later. Compatible with iPhone, iPad, and iPod touch.; developed by Nick Dolezal; Free

https://itunes.apple.com/us/app/safecast/id571167450?mt=8

Pointcast Mobile App iOS



The Pointcast iOS app

The Pointcast iOS app provides access to realtime data

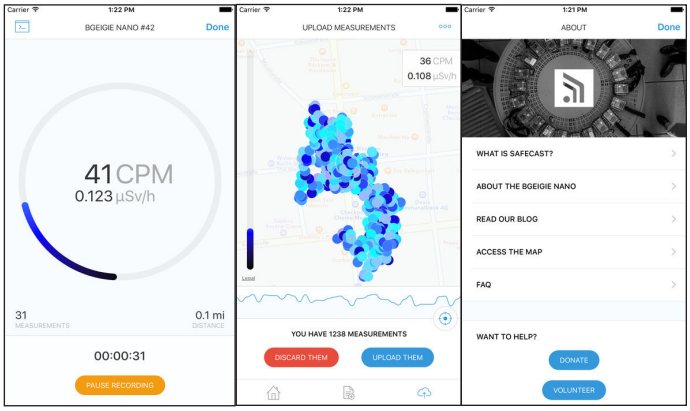
streamed by the Safecast Pointcast system. It replicates the web-based functionality of our online visualizations at http://realtime.safecast.org/. This is the first version, and it is highly useable.

Current version: 1.0.3; Requires iOS 9.0 or later. Compatible with iPhone, iPad, and iPod touch; developed by Mitsuo Okada; Free

https://itunes.apple.com/us/app/pointcast/id1133648289?mt=8

Bluetooth apps:

Safecast Drive iOS



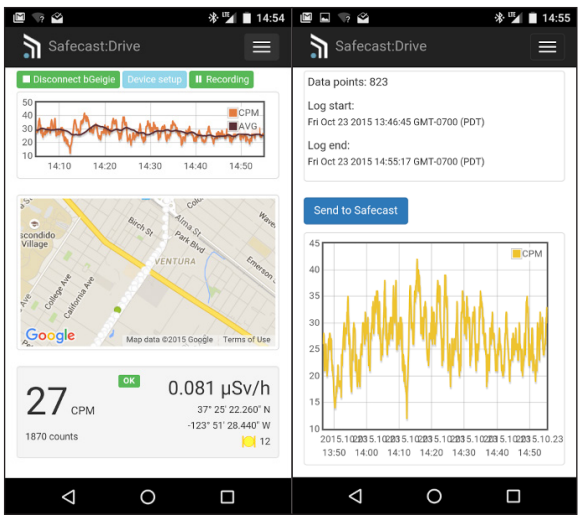
Safecast Drive for iOS enables users to upload data from their bGeigie via their iOS device using Bluetooth

The Safecast Drive iOS app makes it possible to record and upload data from a BLEBee Bluetooth adapter-equipped bGeigie Nano directly to the Safecast database via an iOS device. This obviates the need to remove the bGeigie's microSD card and upload using a computer. The app provides realtime feedback and allows data review and management.

Current version 1.1.2; Requires iOS 8.0 or later. Compatible with iPhone, iPad, and iPod touch; developed by Marc Rollin; Free

https://itunes.apple.com/us/app/safecast-drive/id996229604?mt=8

Safecast:Drive Android



Safecast:Drive for Android enables Safecast data uploads from an Android device.

Like its iOS counterpart, this Android-based app makes it possible to upload data from a Bluetooth-equipped bGeigie Nano via an Android-based mobile device. Developed by Edouard Lafargue and based on his MIT-licensed, open source wizkers.io framework, it saw several updates in 2016-2017. Most of these improve connectivity with various versions of the BLE module and Android Bluetooth implementations. Analytics show that over 100 volunteers have used the app to upload data so far.

Currrent version: a0.4.6; Requires Android 4.0 and up; developed by Edouard Lafargue; free.

https://play.google.com/store/apps/details?id=io.wizkers.safecast.drive&hl=en

Video explaining setup: https://www.youtube.com/watch?v=SUkqfWOGyzo,

1.7 Education and Training

A Safecast volunteer assists a Japanese junior high-school student at the Mori Kids Summer Workshop in Tokyo, August 2016.

From the beginning it was necessary for Safecast members to train other volunteers, and over time education and training have grown to become one of our most important core competencies. We've always considered events and outreach activities to be an important part of communicating what we are doing, building our community, and training our volunteers. We frequently hold workshops, run hackathons, give talks, and participate in public symposia. Until now we have generally discussed workshops, courses, social media, participation in expert conferences, and academic output together, under the category of "outreach." Here, for the sake of clarity, we will break these activities down a bit further while acknowledging that they continue to overlap considerably.

1.7.1 Workshops:

We continue to hold workshops to teach people in Japan and other countries how to build and use bGeigie Nanos, and about radiation issues in general. Over the past year some of our workshop activity has developed into focussed community-building initiatives, aimed at increasing participation in specific geographic regions. These include:

Safecast Asia Network— Our first workshop in Asia outside of Japan was held in Taipei in October 2014. This was followed by another well-attended workshop there the following year, and by an even larger one in Hong Kong in December 2015. As interest from other Asian countries has grown, we launched the Safecast Asia Network so that supporters in Asian cities who have helped organize events and start volunteer communities can get to know each other better. Our longterm partner Loftwork has been central to this initiative, and has hosted several workshops at its FabCafe space in Taipei. Our Asia Network activity is geared towards people who have the time and resources to build bGeigie Nanos, as well as educational programs for elementary and middle-school students. In addition to workshops held in recent months in Taipei, Hong Kong, and Seoul, others are being planned for Singapore and Bangkok.

Safecast Asia Network kickoff in Taipei, May 2017.

International participants assist each other at the joint IAEA/ICTP expert workshop in Trieste, Italy, March 2017.

Joint IAEA/ICTP Workshop Trieste, Italy, March 2017 — This intensive three-week expert workshop on citizen science for environmental measurement held at the International Center for Theoretical Physics (ICTP) in Trieste, Italy, quickly jump-started Safecast activity in 25 developing nations in Africa, Central and South America, and the Middle East. Safecast staff were joined by about 30 other lecturers and speakers who covered topics such as open-source hardware design, digital fabrication, data visualization, sensor calibration, and scientific communication skills. The emphasis was on hands-on training and teamwork. The 29 workshop participants returned to their home countries with bGeigies they had built, prepared to continue to participate in Safecast and encourage others to do so as well.

Detailed program: http://wireless.ictp.it/citizen-science_2017/

Blog post: https://blog.safecast.org/2017/03/25-nation-workshop-in-trieste/

Other recent workshops, primarily devoted to teaching groups of new volunteers how to build and use the bGeigie Nano, as well as workshops for younger children who learn about radiation and build our simple education-oriented kGeigie, include:

- April 2016: Tokyo - Safecast 5th Anniversary bGeigie Workshop
- July 2016: Tokyo - Mori Kids Summer Radiation Workshop
- Oct 2016: Kyoto - MTRL workshop
- Nov 2016: Tokyo - E2D3 workshop
- Dec 2016: Seoul - bGeigie workshop (SAN)
- Jan 2017: Tokyo - Safecast Hackathon
- April 2017: Hong Kong - Safecast bGeigie workshop
- NCTU workshop
    - Taipei - Safecast bGeigie workshop
    - June 2017: Tokyo - MakerBay workshop
- July 2017: Seoul - Safecast Asia Network bGeigie/kGeigie workshop
- August 2017: Hong Kong - Citizen Science workshops at Youth Square
- August 2017: Hong Kong - Citizen Science workshops at Citizen Science Faire
- August 2017: Tokyo - Mori Kids Summer Radiation Workshop

1.7.2 Educational initiatives:

We also have ongoing relationships with MIT Media Lab, Keio University, Aoyama Gakuin University, Kanazawa Institute of Technology, and San Diego State University. This includes an ongoing one-semester undergraduate course course on the Safecast method at Aoyama Gakuin University in Tokyo. In addition, each summer we host overseas university student interns.

1.8 Outreach

In addition to the educational programs described above, Safecast conducts many other outreach activities geared to specific audiences. These include public conferences and events organized by Safecast, expert-oriented activities and participation in academic conferences, academic output such as research papers, events and presentations for the

general public that are not specifically workshop oriented, exhibitions in an art or design context, and social media content generated by Safecast itself. These are listed and described below.

1.8.1 Public conferences and events organized by Safecast:

Safecast organizes large public events several times each year. These include the Safecast Conference series which provides an opportunity for our wider community and the general public to hear from interesting and active members of our network and engage in dialogue about the wider implications of the Safecast project. In addition we hold a New Year event in Tokyo to celebrate our volunteers and bring them up to date about what was accomplished over the previous year and what's in store for the next.

Beth Simone Noveck of NYU GovLab makes a memorable point during her OWOD keynote

Our World Our Data (OWOD) Conference, MIT Media Lab, Boston, 4/30/2017

Citizens have the right to be informed, to be consulted and adequatey represented in decisionmaking, and to have recourse to legal resolution when this does not happen. All of these require open access to data, whether it's about the environment, demographics, or any other aspect of governance.The higly publicized moves by the Trump administration to deny public access to environmental information that had previously been openly available was alarming to many. But in fact it merely highlighted a greater longstanding problem of the lack of the kind of openly available data we shouldexpect and demand.The Our World Our Data (OWOD) Conference was a unique, high-profile public event brought together notable thinkers and practitioners who promote openness and transparency in government, industry, medicine, law enforcement, the environment, and many other fields. Safecast used the opportunity to put our open, citizen-based environmental data-gathering mission in context with the global openness movement, and to strengthen our communication with people who are engaged in similar initiatives. The Center for Civic Media at MIT Media Lab, which hosted the event, is Safecast's spiritual home in the world of ideas. Much of Safecast's values and ethos has emerged from principles of social communication and effective action nurtured at the MIT Media Lab, under the guidance of Director Joi Ito, who is a Safecast co-founder, and Ethan Zuckerman, director of the MIT Media Lab's Center for Civic Media. Safecast co-founders Pieter Franken and Sean Bonner are Associate Researchers at the Media Lab. Presentations and videos from the event are available online:

https://www.media.mit.edu/events/our-world-our-data/

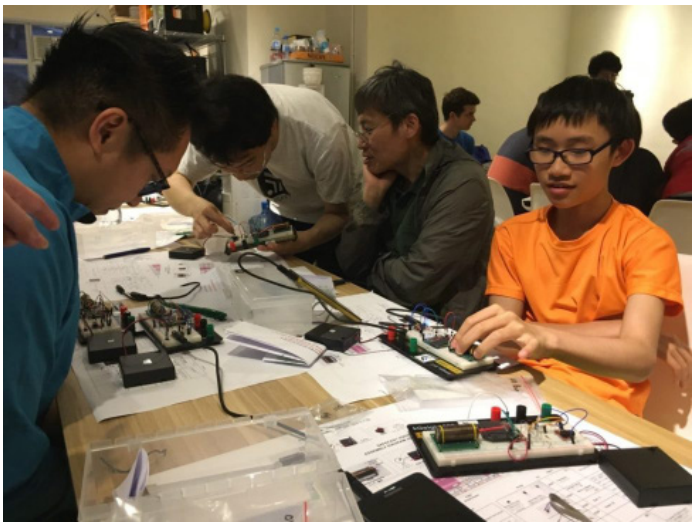
https://blog.safecast.org/2017/06/our-world-our-data-videos-presentations/

Other large public events organized by Safecast:

» March 2016: Tokyo - Safecast 5th Anniversary Event

» Jan 2017: Tokyo - Safecast New Years Event

1.8.2 Safecast Asia Network:



Participants at the Safecast Asia Network workshop in Hong Kong, May 2017

Over the years we have seen a steady expansion of our volunteer community across Asia. The expansion is driven by concerns relating to nuclear safety (Taiwan, Hong Kong and Korea), and especially concerns regarding the safety of air and water in all Asian countries. Though the news is full of the bad air in China, it's a problem affecting all Asian nations which generall put economic growth ahead of the quality of life. We therefore see Asia as a key region for Safecast to grow and bring impact to local communities ability to gather data to improve their environments. To further encourage our volunteers to grow local initiatives around Safecast, we have started the Safecast Asia Network program. The main purpose is to bring likeminded volunteers together spanning different disciplines who are interested in taking leadership to organize Safecast activities in their own communities. Currently this network building has focussed on Taiwan, Hong Kong, and South Korea, and we hope to expand it to other Asian nations such as Singapore, Thailand, India and others in upcoming months. Some of this network building has been aided by our partner Loftwork, who have helped us organize workshops and bring people together, and by active volunteers who took the initiative to setup workshops over the past 2-3 years. In 2017 we have been able to organize multiple workshops in Hong Kong, Seoul and Taipei. In Hong Kong the group has recently started to do their own workshops without needing direct support from our group in Japan. We expect the Safecast Asia Network to grow over

the coming 2-3 years and be a key driver to expand our network of Solarcast sensors.

1.8.3 Expert-oriented outreach activities:

Safecast regularly organizes workshops and discussions for members of the expert community, and is frequently invited to participate in specialist-oriented conferences and meetings. The effectiveness of Safecast's public communication and engagement has been recognized by the expert community and observed with great interest by major advisory and regulatory bodies. In addition, Safecast publishes its method and findings in the academic literature, and is a subject of academic research itself. Within the expert sphere we are a voice for openness and transparency.

Expert symposia, academic presentations, etc:

» March 2016: Geneva - CERN: Gathering for Open Science Hardware

  » Wash DC - NRDC workshop

  » Wash DC- DARPA, EPA RADNET presentations

  » Wash DC - Nuclear Security Summit SSNF Conference

» April 2016: Vienna - European Geophysical Union (EGU) Conference

» June 2016: Bucharest - RICOMET Conference

  » Paris - Dauphine Univ. Presentation

  » Paris - IRSN presentation

» Nov 2016: Vienna - IAEA Plenary Meeting of the Network on Environmental Management and Remediation

» Dec 2016: Luxembourg - Nuclear Transparency Watch (by video)

  » Tokyo - IAEA Regional Workshop on National Stakeholder Mapping and Communication Plan

» March 2017: Trieste - IAEA/ICTP expert workshop on citizen science for environmental measurement

» April 2017: Boston - Our World Our Data (OWOD) Conference, MIT Media Lab

» June 2017: Tokyo - Radiation Safety Forum talk

» Paris - IRSN presentation

» Vienna - RICOMET Conference (at IAEA)

Academic output:

In June 2016 Safecast published its first major academic paper in a leading scientific journal. To date, this paper has been downloaded approximately 5000 times, and has been selected for inclusion in the Journal of Radiological Protection Highlights of 2016, which includes the most influential research published in JRP in 2016:

Safecast: successful citizen-science for radiation measurement and communication after Fukushima

Brown, et al, Journal of Radiological Protection, Volume 36, Number 2, June 2016

http://iopscience.iop.org/article/10.1088/0952-4746/36/2/S82/meta

Citizen-based radiation measurement in Europe: Supporting informed decisions regarding radiation exposure for emergencies as well as in daily life; Brown, Baumont, Kuča, Helebrant; Ricomet 2016 (poster)

Joint ICTP-IAEA Workshop on Environmental Mapping: Effective education and training for involving citizens in environmental monitoring; Brown, Moross, Darby, Zennaro; Ricomet 2017 (poster)

Research about Safecast:

Since 2011 there has been a steady stream of academic research by others which analyzes the Safecast project and its results in social and scientific terms. Over the past year these have included:

Citizen monitoring during hazards: validation of Fukushima radiation measurements; Hultquist, C. & Cervone, G. GeoJournal (2017) https://link.springer.com/article/10.1007%2Fs10708-017-9767-x

Validating Safecast data by comparisons to a U. S. Department of Energy Fukushima Prefecture aerial survey; Coletti et al, Journal of Environmental Radioactivity, Volume 171, May 2017, Pages 9-20

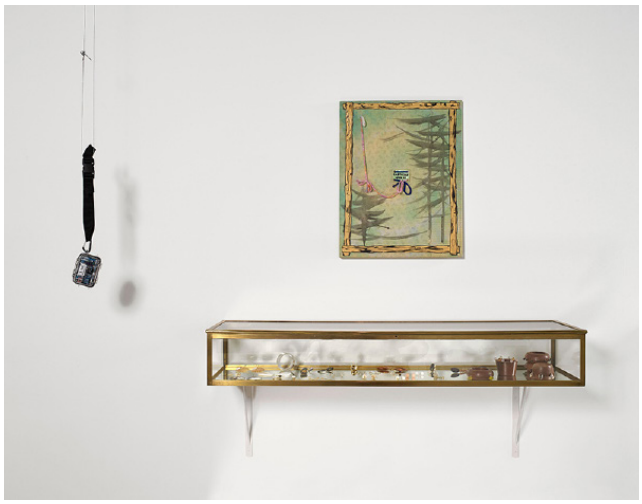
http://www.sciencedirect.com/science/article/pii/S0265931X17300218

1.8.4 Other public and invited events and presentations:

» March 2016: Tokyo- Foreign Correspondents Club of Japan: Safecast and the Fukushima Disaster: Five years of lessons learned for citizen-based radiation monitoring

    - » ACCJ American Chamber of Commerce - Tokyo
- » July 2016: Tokyo - RSA Japan Fellowship Network: Developing Grassroots Social Enterprise Projects in Japan
- » August 2016: Tokyo - Tokyo Univ: 2016 International Students' Radiation Workshop in Fukushima presentation
- » Sept 2016: Aizu - TedX Aizu
- » Nov 2016: Tokyo - RSA Japan Fellowship Network: Radiation and Science Journalism
- » Jan 2017: Tokyo - Safecast New Years Party
- » Feb 2017: Boston - Safecast retreat
    - » Tokyo - CSLA presentation
- » May 2017:: NYC - Japan Society of NY
    - » Amsterdam - Phonegap Day EU
- » June 2017: Tokyo - SMU Singapore group presentation
- » July 2017: Tokyo - CISAustralia University Student group presentation
    - » Tokyo - Japan Society of New York Junior Fellows Leadership Program presentation
    - » Tokyo- Keio University. Featured research at Blockchain Alliance launch "workshop" (BASE)

1.8.4 Exhibitions:



Safecast bGeigie Nano exhibited as an artwork, "Bodikon" exhibition, Belmacz Gallery, London

Safecast has been featured in a number of exhibitions in different parts of the world in an art or design context over the past year, including:

Big Bang Data (Barcelona, London, Buenos Aires, Singapore, etc.), 2015-2017

Taipei Digital Art Festival, 2016

"Bodikon," Belmacz Gallery, London, 2017

Ars Electronica, Linz, 2017

1.8.5 Social media:

Safecast continues an active social media presence, with frequently updated blogs in English and Japanese, and active streams on Facebook and Twitter. Most of our presentations can be found on our SlideShare page. This content is primarily generated by Safecast and directed towards our community as well as the wider public.

Safecast Blog — News and updates about what Safecast is doing, as well as information and analysis of issues of concern, such as the recent storage tunnel accident at Hanford nuclear facility; forest fire in Namie, Fukushima; reported release of I-131 in Europe, and others:

https://blog.safecast.org

https://safecast.jp

Facebook (English) https://www.facebook.com/safecast/

Facebook (Japanese) https://www.facebook.com/SAFECASTJP/

Twitter https://twitter.com/safecast

Vimeo https://vimeo.com/safecast

Slideshare https://www.slideshare.net/safecast/presentations

,1.9 Press & Publicity

The Safecast project emerged from the possibilities of the internet age and "runs" on a fabric of social media, the cloud, chat rooms, Slack, etc. Safecast does not spend any resources on advertising, relying instead on word of mouth. However we do get regular coverage from media of all types, and we see these as endorsements that what we do remains relevant. Over the past years we have been featured, mentioned, or covered in over 200 media publications—printed press, books, TV, blogs, online, etc. (approximately 35 newspaper articles in Japan and abroad, 12 features by major broadcast media, at least 60 mentions in online media, etc.)

Contributing to media is a significant activity for Safecast, as it allows our message to be propagated to a larger audience and also helps us to connect to new volunteers. Not only do we appear in articles, we also have become a go-to source for journalists who want to learn about radiation and scientific findings relate to the Fukushima disaster, and we have spent countless hours with reporters to share what we know and connect them with relevant people and organizations. We often accompany reporters into the field. We rarely seek coverage, however, and generally wait to be approached. When we feel information could be more accurately and informatively represented, though, we're not shy about reaching out to journalists with more reliable information.

Though we have historically gotten more media coverage outside of Japan than inside, Safecast continues to attract mainstream media attention in Japan. The following are

highlights of our recent media coverage:

Press Highlights March 2016 - July 2017:
(This list includes articles and references to Safecast in print and web media, as well as appearances in broadcast media)

May 2016:

National Geographic Blog: Is it Safe to Visit Fukushima?

http://voices.nationalgeographic.com/2016/05/19/is-it-safe-to-visit-fukushima/

June 2016:

The wave of reconstruction: five years after the north-east Earthquake

http://www.thewaveofreconstruction.com/

July 2016:

LA Times: Citizen science takes on Japan's nuclear establishment

http://www.latimes.com/world/asia/la-fg-japan-safecast-snap-story.html

Related video: Safecast teaches Japanese citizens how to monitor radiation

http://www.latimes.com/87913832-132.html

Bulletin of the Atomic Scientists: Crowdsourcing the environment of Fukushima and beyond

http://thebulletin.org/crowdsourcing-environment-fukushima-and-beyond9691

Aug 2016:

Adafruit Industries Blog- Makers Show How to Use Tech to Tell If It's Safe yet in Japan

https://blog.adafruit.com/2016/08/02/makers-show-how-to-use-tech-to-tell-if-its-safe-yet-in-japan-safecast-nuclear-citizenscience/

NYT: Japan's $320 Million Gamble at Fukushima: An Underground Ice Wall

https://www.nytimes.com/2016/08/30/science/fukushima-daiichi-nuclear-plant-cleanup-ice-wall.html?_r=0

BBC World Service Radio Newsday : (Live on-air interview re: Fukushima Daiichi underground ice wall)

http://www.bbc.co.uk/programmes/p045pgd6

Oct 2016:

Veille cartographique 2.0: Safecast Dataviz, une mise à jour majeure (French)

http://veillecarto2-0.fr/veille-2/cartographie_collaborative_et_outils-2-0/safecast-dataviz-mise-a-jour-majeure/

Nov 2016:

Belgian TV: "Alors On Change": Les Explorateurs - RTBF Auvio (French)

http://www.rtbf.be/auvio/detail_les-explorateurs?id=2160431

NYT: New Quake Tests Resilience, and Faith, in Japan's Nuclear Plants

http://mobile.nytimes.com/2016/11/22/world/asia/japan-earthquake-tsunami-fukushima.html?referer=https://www.google.co.jp/

Dec 2016:

Whiplash, book by Joi Ito and Jeff Howe; Chapter 2: "Pull over Push" describes the Safecast story

Jan 2017:

Belgian TV RTBF Auvio: Alors, on change ! - Japon en transition

https://www.rtbf.be/auvio/detail_alors-on-change?id=2177075

Feb 2017:

Washington Post: Japanese nuclear plant just recorded an astronomical radiation level. Should we be worried?

https://www.washingtonpost.com/news/worldviews/wp/2017/02/08/japanese-nuclear-plant-just-recorded-an-astronomical-radiation-level-should-we-be-worried/

Tepco Struggles to Communicate Radiation Spike That Wasn't

http://www.bloombergquint.com/business/2017/02/09/tepco-struggles-to-communicate-the-radiation-spike-that-wasn-t

National Geographic Voices: After Alarmingly High Radiation Levels Detected, What Are the Facts in Fukushima?

http://voices.nationalgeographic.com/2017/02/22/after-alarmingly-high-radiation-levels-detected-what-are-the-facts-in-fukushima/

March 2017:

BBC World News: The Travel Show: Checking radiation levels in Fukushima, Fukushima Skiing,

http://www.bbc.co.uk/programmes/p04vjdr1

NYT: Japanese Government and Utility Are Found Negligent

in Nuclear Disaster

https://mobile.nytimes.com/2017/03/17/world/asia/japan-fukushima-nuclear-disaster-tepco-ruling.html

Trieste, Italy RAI TV News re: workshop at ICTP (in Italian):

TG Friuli Venezia Giulia Edizione delle 19.30

http://www.rai.it/dl/RaiTV/programmi/media/ContentItem-e66f2474-0365-4e8f-8945-9540c7eeccb4.html

Trieste, Italy RAI radio: live interview

ICTP News Blog: Science for the People

https://www.ictp.it/about-ictp/media-centre/news/2017/4/citizen-science-workshop.aspx

July 2017:

NHK TV Miraijuku: Welcome to Fukushima! (Japanese)

http://www.nhk.or.jp/ashita/miraijuku/

Sitra: Ten fascinating initiatives in societal progress -

https://www.sitra.fi/en/articles/ten-fascinating-initiatives-societal-progress/

1.10 Funding & Support

NPO Status & Advisory Board

Different currencies and non-profit requirements on a global level can be complicated, for ease of local donations and regional integration, Safecast is housed within 3 separate organizations. In the USA, Safecast is a project of The Momoko Ito Foundation, a registered 501(c)3 non-profit organization. Outside of the USA, Safecast exists as a dedicated NPO in Japan ("Ippan Shadan Hojin") and a (non-profit equiv) ANBI in The Netherlands, covering Asia and Europe respectively.

While Safecast is a largely volunteer organization, ongoing overhead and administrative costs as well hardware and travel costs are needed for the team to complete the mission. Since inception, Safecast has operated with an under $1M a year budget, and plans reach $1.5M in 2018 for wider deployment of the Solarcast network. The current roadmap is to grow towards $3M a year by 2020. This funding comes from a number of sources, including:

The Shuttleworth Foundation

Safecast co-founder Sean Bonner was awarded a Fellowship with the Shuttleworth Foundation in 2014 and was invited back for 2 consecutive years, the maximum allowable time. In addition to being a wonderful braintrust and support group, this has provided close to $1M for overhead and project costs through 2017.

The Knight Foundation

Between 2011 and 2013, the John S. and James L. Knight Foundation was the primary funder for Safecast, awarding several grants totalling $650k to aid with many different aspects of the Safecast mission.

Individual Donations

We have also received donations from individuals and other foundations that have helped with our project goals, including Reid Hoffman, Global Giving, The Annenberg Foundation and The Japan Society.

Contributions in kind

We would like to thank the following companies for offering us help with our office, discounted equipment and services:

» Loftwork

» Medcom International -- Slack

» Adafruit

» Sparkfun

» Pelican Case

» MediaTemple

» Cloud66

» Kromek (Safecast 6D)

New Office

Safecast has only one office globally and has been co-located at Loftwork offices since 2012. In February 2017 we moved from the Loftwork offices on the 8F to the 3F of the same building, and now share space in COOOP, a new Loftwork initiative to support longer term projects with a creative environment. The new office space has allowed us to have more efficient storage space for our projects and equipment, and also boasts a larger workbench and flexible meeting space. We remain extremely grateful for the wonderful collaboration with Loftwork, especially their founders Chiaki Hayashi and Mitsu Suwa, Daiki Kataoka (Fabcafe Tokyo) and Ti m Wong (Loftwork Taipei/Hong Kong)

1.11 Collectibles

A full set of Safecast-related pins and challenge coins

For years, Safecast made t-shirts and that's about it. But over the past year we decided to have a little more fun, and have designed a few pins and challenge coins as well. The pins include one with the Safecast Logo and one in the shape of a bGeigie Nano. We expect to continue t produce these. The challenge coins are limited-edition. The first two were one to commemorate our first five years, and another for participants in the "Our World, Our Data" conference at MIT Media Lab in April 2017.

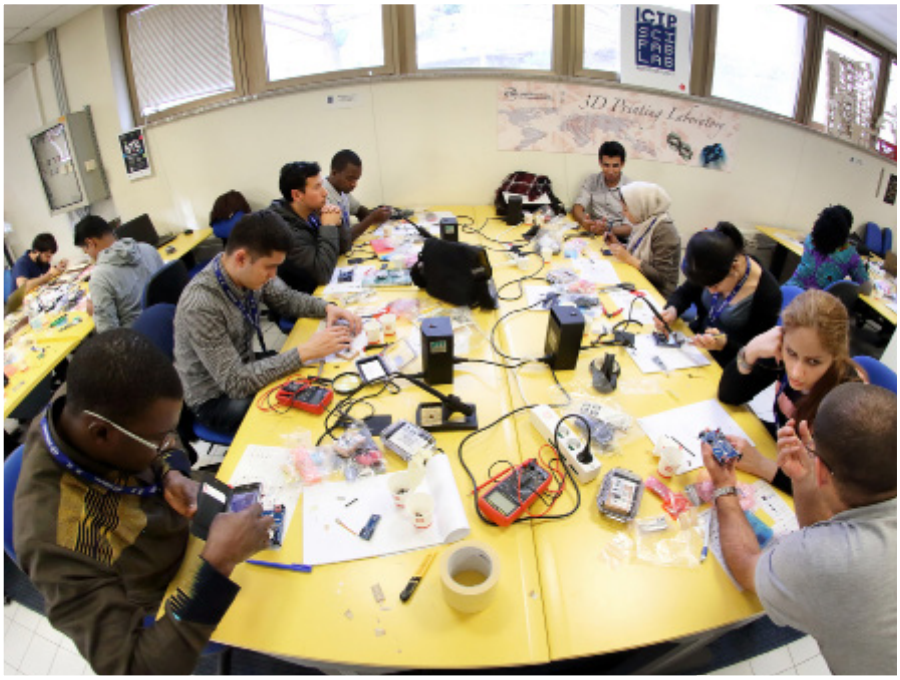
1.12 Always Improving

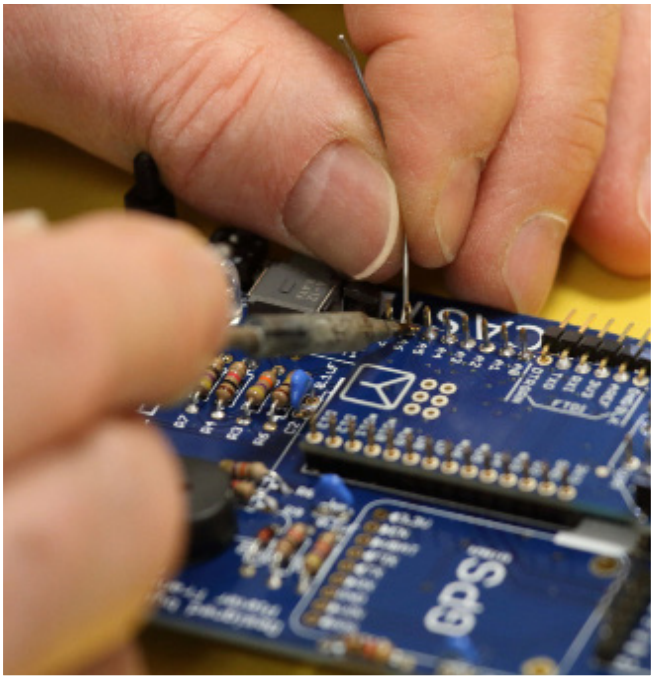
Safecast is the work of volunteers, and is by no means "finished", "perfect" or "the final word". Some would say it's nothing to boast about—lots of work to do! There's plenty of room for improvement and "wouldn't-it-be-nice-ifs." This applies to the Safecast Report as well. The information provided here represents the best data we have found, and the best of our understanding and knowledge, but, as a Dutch proverb says, "Don't skate over one-night ice." We encourage readers and volunteers to check the data and information themselves and form their own opinions about the environment we're living in. "Is it safe?" is a question whose answer differs from individual to individual. Our daily lives are full of risks, but we shouldn't let that paralyze us. However, being aware will hopefully allow us to make better decisions, and to focus our individual actions to better improve our environment and our lives.

If you see anything you think could be done better, needs fixing, or can be complemented, or if you simply want to help out or to contribute, let us know.

And if you want to learn how to make your data open and more useable (as a citizen, company, university, or government body), we're here to help.

Get in touch: info@safecast.org and @safecast on twitter





Top left: The Joint ICTP-IAEA Workshop on Environmental Mapping held at the ICTP in Trieste, Italy, in March 2017, attracted a diverse group of experts from around the world.

Center left: International experts build bGeigies at the ICTP.

Bottom left: ICTP workshop participants conduct a group data-collection field exercise in Venice.

Bottom right: Most Safecast workshop participants have never soldered before, but soon become proficient.

Top: Our amazing group of speakers enjoys a final dinner following the OWOD confeence at MIT in April, 2017.

Bottom left: Azby steadies Joe's ladder during a particularly tricky Pointcast sensor installation in Namie, Fukushima, in July 2016

Bottom right: The Safecast team says farewell to our supporters from the Japan Society of NY, May 2017..