The Geospatial Intelligence Continuum during Sudden Onset Disaster Response

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ABSTRACT

This document will discuss the current methodologies used by New Zealand DART and USAR teams to collect manage, analyse and report on information gathered during the initial and subsequent phases of deployments to a sudden onset disaster (SOD). This will include some of the operational experiences that have formed the current methodology and the outcomes of disaster events with new methodologies applied.

It will further identify and discuss the current systems and processes in place and how they have come about, and then identify a range of opportunities and issues that exist within the Geospatial Intelligence environment to be more effective, both in systems and the development of partnerships to enhance the usability and intuitive nature of these systems and methods.

Finally, the discussion will look to identify a future state for responders to SOD's and the ability and outcomes of proposed and imagined future systems, leveraging off the current Esri packages to provide a starting platform and a desired end state.

KEYWORDS

GEOINT, ESRI, DART, USAR, Intelligence, Information management, HADR,

INTRODUCTION

Search and Rescue is a spatially inherent process and therefore geospatial tools play an integral role in decision making and outcomes for survivors. Fire and Emergency New Zealand (Fire and Emergency NZ) is the legislated provider of Urban Search and Rescue (USAR) capability in New Zealand. In addition, it is also legislatively responsible for a broad range of Rescue functions as part of the Fire and Emergency New Zealand Act of 2017, (Fire and Emergency New Zealand, 2017) including adverse weather response, water rescue, rope rescue and a range of other technical rescue event types.

Fire and Emergency NZ's USAR team is a United Nations, International Search And Rescue Advisory Group (INSARAG) certified "Heavy USAR team" with an identifier of NZL1. The USAR team is a multi-agency team made up predominately of Fire and Emergency NZ personnel, with other agencies supplying specialist staff such as doctors, medics engineers and search dogs.

The USAR team is also multi mission capable and operates both domestically and internationally (Pacific focus) as a Disaster Assistance and Response Team (DART), supporting the New Zealand Governments response to its Pacific neighbours as well as domestic, regional and national response to the increasing adverse weather and natural disasters that New Zealand is affected by.

One of the key roles that the team has been tasked with in recent years, both in the INSARAG and DART roles is the field collection of information pertaining to the impact on affected communities. This has become an effective tasking across all phases (I-IV) of assessment (Australasian Fire Authorities Council, 2016) from wide area to recovery, information gathered by USAR personnel has increased the effectiveness of immediate taskings, detailed phase 3 work, through to recovery and building back better.

This paper will discuss some of the challenges and victories Fire and Emergency NZ have experienced, focusing on the GEOINT (Geo-spatial information management), integrated Esri based systems, such as Survey 123 (Field based data collector), Operations Dashboard (Information display), Workforce (Tasking software), Drone2map (UAV/RPAS mapping software) Insights (Data analysis) and others including Navigator and Explorer, the organisation is developing to enhance the mantra of "Coordination Saves Lives", with the ability to add that "efficient and effective coordination saves more lives".

THE GEOSPATIAL INTELLIGENCE CONTINUUM

Assessment roles, both in the INSARAG and DART space are primarily around the Phase I (Wide area), Phase II (Triage) and Phase III (Worksite or Detailed) assessment levels, with the focus on Phase I & II primarily.

The continuum is broken down into the following, based on the INSARAG model:

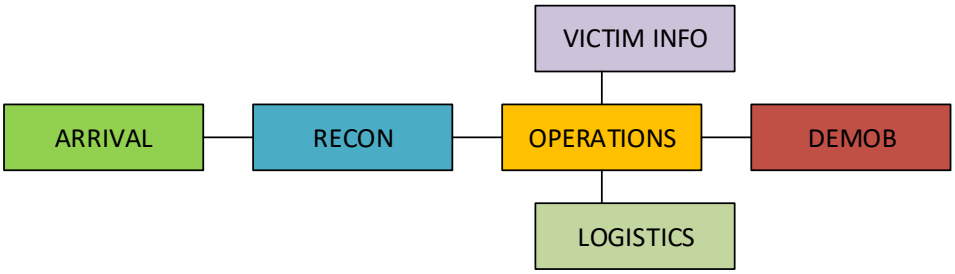


Fig 1. INSARAG Methodology

Each of the elements has a specific set of requirements around Information management, Recon and Operations will be briefly discussed below:

Recon:

While the content may differ between a USAR (INSARAG) based event and a DART response the methodology is the same:

- Capture and transmit operational information back to a command point (CP).
- Display information in near real time
- Enable decision makers
- Enhance taskings and assignments
- Manage resourcing
- Have effective reporting.

The process follows a reasonably orchestrated model, in that phase 1 or wide area assessment look to have a high-level view of the event, pushing back information around areas of damage, sectorisation and any priorities that have been established. Fire and Emergency NZ use geospatial tools based on the ArcGIS Platform (i.e. Drone2Map, Field Apps for ArcGIS). The phase II or triage is about determining operational priorities and is focused on identifying worksites, along with the likelihood for success or focus of phase III assets. Information gathered in this phase are primarily collected by infield systems such as Survey123 for ArcGIS and KoBo Collector. This information however is required to be prioritised and filtered to enable effective deployment of response and other assets. To achieve this, the utilisation of geospatial tools such as Operations Dashboard and Insights for ArcGIS to provide analytics and graphical representation of data to decision makers.

In the INSARAG environment a standard set of data is utilised that is deployed via a range of forms, either on paper or across a range of collectors including Survey123. The ability to use a range of collectors' is made possible using a standard data set or dictionary.

DART operations also use a standard Data Dictionary based on the AFAC National Damage Assessment (NDA) (Australiasian Fire Authorities Council, 2016) model, which provides both data dictionary and methodology around the collection of bespoke data during domestic and Pacific based operations.

Operations:

In both the INSARAG and DART response, Phase III is a work phase, whether it is at a worksite for a USAR

team or repairing infrastructure and light engineering work for DART operations, this phase is about resourcing, status or availability and outcomes (rescues, building repaired etc). A different set of information for a different purpose. Often the recon and operations phase will overlap, requiring the ability to manage the information across a range of functions.

Operations or Phase III work in the USAR world revolves around tasked teams feeding back specific information about progress and specifying resourcing needs, availability and estimated completion times. In-field geospatial tools such as Workforce for ArcGIS and Navigator for ArcGIS are utilised to task teams and inform the Command Point (CP). This information allows forward planning and resource allocation, along with the management of resources and team availability.

DART operations will often have phase II information containing trigger points for other functions, such as welfare, building inspectors, medical, structural support and the like, or will again prioritise work required to be completed by teams to establish and render Humanitarian Assistance and Disaster Response (HADR) functions. Examples include, Edgecumbe flooding triggers that prioritised building inspector work based on phase II RDA on buildings in the flood zone. Likewise, the TC Gita deployment was based around defining phase III priorities and triggers for the Tongan Government for school repairs and other public buildings. The World Bank has also expressed interest around being able to include financial triggers and data capture to inform decisions, increase responsiveness and impact on affected communities.

At this time, primary systems include the use of Survey123, both as a field collector and web-based CP input. Analysis is currently via dashboards based around the operations dashboard early investigations with Insights and Tableau.

ANALYSIS

The key objective of any deployment of responder assets is to obtain useful intelligence to inform decision makers. Therefore, the speed, accuracy and relevance of the intelligence coming back is also critical, especially in the initial stages of disaster.

The ability to display information for analysis to field commanders regardless of discipline, in an informative and intuitive manner leads to effective decision making and a better effect on the outcomes both strategically and at a victim and community level.

The mantra for USAR Coordination functions within INSARAG, is that "Coordination Saves Lives" (UN Office for the Coordination of Humanitarian Affairs (OCHA), 2012) this is equally applicable across all 1st responders and the ability for systems to ensure that coordination and the subsequent tasking's are well informed, accurate and efficient will enhance the axiom considerably.

The field intelligence needs to be formatted and displayed in a way that is fit for purpose and shareable across a range of consumers and formats as required. It is in this area that challenges start to appear around current systems as they are pushed to the limits of the current technology or system/software design.

The demand on deployed elements for information and reporting from a wide range of agencies is a significant pressure point on command and coordination elements. Intelligence outputs must include reporting functions that reduce this burden as well ensuring that the wider political, strategic and organisation components of any SOD, have their needs met with accurate and informed intelligence packages tailored to meet their specific needs

COLLABORATION/SHARING

Disasters are never isolated to one agency or organisation, with even day to day responses to events as part of an emergency service, the engagement and interaction with other agencies is considerable.

The ability to share and have common methodologies and data sets is also a key to success, as intelligence collected during the early phases of a SOD will provide significant information to the recovery phase and inform subsequent actions or reactions post any event.

Much of the effectiveness of information gathering and analysis is determined during collaborative workshopping prior to any event and in the defining of what the end state and outcomes will be from as many actors as possible. This was a lesson was learnt the hard way during the 7.8 magnitude Kaikoura earthquake in 2016, where this was not in place and significant work was required in the field to get a passable result. However, a good example of this is the work done through the Australasian Fire Authorities Council (AFAC), where a Data Dictionary and methodology was established for all agencies in Australia and New Zealand to ensure a common minimum data set for use in SOD events.

Fire and Emergency NZ have utilised this for both onshore (Kaikoura, Edgecumbe, Ngongotaha, National Park) and off shore (Vanuatu, Fiji and Tonga) quite effectively, including developing touch points and cooperation with other agencies such as MCDEM and Police.

GEOINT systems must be able to share and collaborate and this means interagency collaboration to develop effective systems and or data sets before events take place and can be used by agencies for their own needs but are also able to be used by recovery agencies to reduce the potential for impact in any future events.

CURRENT STATE AND OPERATIONS:

Fire and Emergency NZ operates data collection across a wide scope of activities and this scope is forever increasing, with the increased mandate contained with the new Fire and Emergency NZ Act 2017.

Data collection for operations is collected via a range of processes, paper and standalone electronic media, RPAS or Drones, High Definition cameras on a range of airframes, field data collectors, and the use of social or crowd sourced media to inform decision makers.

From an ArcGIS Platform perspective Fire and Emergency NZ's enterprise mapping platform is Esri based, Fire and Emergency NZ utilises Drone2Map, Survey 123, Insights, Operations Dashboard, Workforce and most other applications available in some form or another.

One of the key factors in generating successful outcomes from using Geospatial tools for major events, is ensuring that Fire and Emergency NZ can utilise the systems and applications in day to day business as usual as well. Fire and Emergency NZ has a significant number of opportunities to develop this capability as it builds towards a mobility-based work force.

The organisation has considerable Information and Communications Technology (ICT) capability to capture and process the data via cloud-based systems and mobility, as well as hardware and intranet solutions.

Fiee and Emergency NZ has deployed these systems in a number of events, with each iteration providing improvements and new challenges.

Two examples that will be discussed in the following passages are the flood response to Edgecumbe and the USAR/DART response to TC Gita in the Kingdom of Tonga.

EDGECUMBE (APRIL 2017)

Event: On April 6th, 2017, a stop bank breached its banks on the Rangitikei River, a state of emergency was declared as water flowed into the town Edgecumbe due to heavy rains following and preceding TC Cook and Debbie.

Requirements: Urban Search and Rescue Commanders deployed as part of Fire and Emergencies regional response and as part of multiagency planning functions are tasked to provide intelligence back to the local Civil Defence Emergency Operations Centre (EOC). The tasking meant providing RPAS (Drone) operations, that include video and orthomoasic imagery and Rapid Damage Assessment (RDA) (Triage/Phase II) and possibly supporting Phase III (detailed structural stability) assessments.

Actions: Previous operations, including the magnitude 7.8 earthquake in Kaikoura had resulted in the application of the NDA model into a Survey 123 based form that was used to collect RDA information. This information included phase III trigger points for welfare and building inspections.

The use of Remotely Piloted Aerial Systems (RPAS) resulted in the production of High Definition (HD) video and orthomosaic layers for mapping the current flood levels in the town. This information was processed by Drone2map and a cloud-based provider (DroneDeploy), which were inserted into the mapping and subsequent dashboarding for both Fire and Emergency's Command Point (CP), Regional Coordination Centre (RCC) and the Civil Defence EOC, providing enhanced and up to date situational awareness for operations and planning.

For recovery functions the information provided the ability to give residents a one stop place for all information and activities taken against their address point and also informed planners for the rebuild of the areas and depth of inundation and the like.

Outcomes: Learning from this event included:

Value of interagency interoperability using Esri based systems ArcGIS online (AGOL).

Collaborative work between Council, Fire and Emergency, Eagle Technology and the NZ GIS for Emergency Management (NZGIS4EM) Community provided a good example of what's possible

Dashboarding requires significant skills and knowhow to set up and is very time consuming

Using a Survey123 form prepared in advance saved a lot of time and was easy to deploy

Prepopulation or selectable text is key rather than free text entries

In field data collection worked well, even when staff had limited training

Reporting is a key component of any event

Tasking functions would benefit from an application such as Workforce for ArcGIS

Drone footage proved invaluable for Situation Awareness and informed decision making and was easily shared with other agencies

The size of drone captured raw imagery needs to be considered; large datasets take longer to process and proved difficult to manage

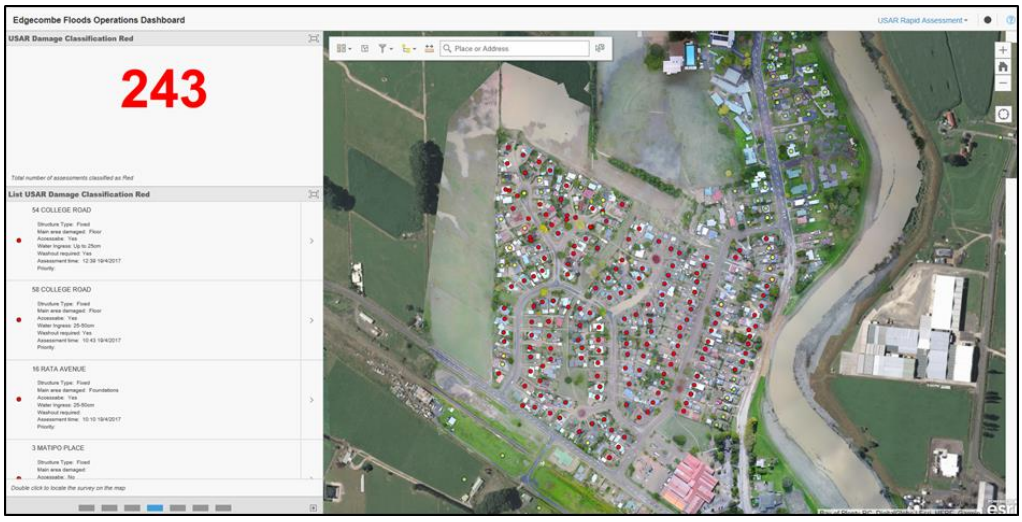
Drone imagery can be processed in the field or using cloud technology. Cloud benefits from scalability however transporting large datasets to backend servers was an issue

Drone2Map (Esri) was used to process drone imagery both in-field and on scalable cloud servers with great success.

The web-based drone mapping platform DroneDeploy was also used to great success with easy pre-set outputs. DroneDeploy uploads and processes images one at a time which assisted with the data transfer overhead.

The ability to present information in a combined state via the Esri Operations dashboard (below) provided the EOC with a good situational awareness and also gained political confidence

Edgecumbe Dashboard showing RDA over Drone Orthomoasic



TONGA (TC GITA (FEBRUARY 2018)

Event: Tropical Cyclone Gita impacted the Kingdom of Tonga as a Category 5 cyclone on the evening of the 12th of February 2018. Significant damage occurred to all parts of the Kingdom including many public buildings, churches, shelters, schools and medical facilities.

Requirements: As part of the New Zealand All of Government (AoG) response an initial assessment team (IAT) was dispatched to Tonga, this team included two Fire and Emergency NZ USAR Commanders, along with MFAT, NZDF and MoH (NZMAT)[1] staff.

As a result of this team's work, a request was received from the Tongan Government for an RDA program to conduct phase II assessment of an estimated 200+ damaged buildings, including Churches, Shelters and Schools.

[1] Ministry of Foreign Affairs and Trade, New Zealand Defence Force, Ministry of Health (New Zealand Medical Assistance Team)

This was subsequently extended and resulted in assessments of medical centres and an increased building count of some 348 buildings.

Actions: As a result of the Tongan Governments request MFAT approved the deployment of an NZ USAR DART element specifically tasked and equipped for the RDA role. The team also include four Australian Fire and Rescue New South Wales (FRNSW) USAR personnel that were integrated into the New Zealand DART team (NZL) to provide both the NZ and Australian Governments a united response and HADR capability into Tonga.

The team also include and GEOINT intelligence officer as part of the DART Command Support Cell (CSC), who was briefed and tasked with developing a range of dashboarding, analysis and reporting tools and outputs for delivery to the Tongan National Emergency Management Office (NEMO) once the team had completed its work. The time frame predicted was to have the mission completed and the team demobilised within 8 days.

The methodology and process included the use of the NDA based damage assessments utilising Survey 123, Operations Dashboarding, with tasking for RPAS (Drone) operations utilising Workforce for ArcGIS and in-field situation awareness being provide via Explorer for ArcGIS. The final briefing was developed and presented in a Story Map and Map Tours.

The team was divided into squads, with allocated geographic sectors or function (RPAS) and deployed into the environment. This even included an away mission to E'ua, which is the other main island in the group.

DART elements were fortunate that overall the 3/4G system was operational most of the time, which allowed the information to be transmitted back to the Command Point and the New Zealand High Commission almost instantaneously, but in some cases the tablets held the data until a reliable connection was available or they returned to the CP and the USAR teams own local Wi-Fi capability picked up the data and transferred it to ArcGIS Online.

RPAS operations provided 20 sec aerial clips of damaged buildings which were later inserted into the story boards to provide clarity and perspective to the RDA data that was provided in the briefing material.

The mission was conducted over a 6-day period with the teams completing the field operations on the 5th day, having surveyed some 348 buildings and conducting 30 + UAV flights. Considerable work was undertaken by the CSC and the UAV pilots to develop the full intelligence package that included PDF reports for each building, video clips for Red and Yellow damage classifications, GIS data packages, and the storyboard presentation.

The intelligence package was provided to the head of NEMO and other Government departments and NGO's including the World Bank, who expressed significant interest in engaging with the team around developing the phase II RDA to capture some of their criteria as part of current USAR and DART processes.

The purpose of the mission was to provide the Tongan Government a phase II/triage assessment package that would allow them to prioritise phase III or detailed follow up work and to provide them with confidence that they had enough operating shelters and places of safety should another cyclone arrive.

Outcomes: Learnings included

Enhance the home-based support

Dashboards need to be prepared during peacetime to assist with easier deployment planning and preparedness

Ready to go options for collection, analysis and tasking

Don't expect to apply New Zealand options in other countries.

Integrating crowd sourced images is a good option

Many agencies don't actually know what they want or what's available via GEOINT

Integrated storyboard based briefing packages are an excellent way to present information to an operational audience

Use web service or social media for unrestricted information sharing

Must be able to easily produce high quality paper-based reporting as well as electronic.

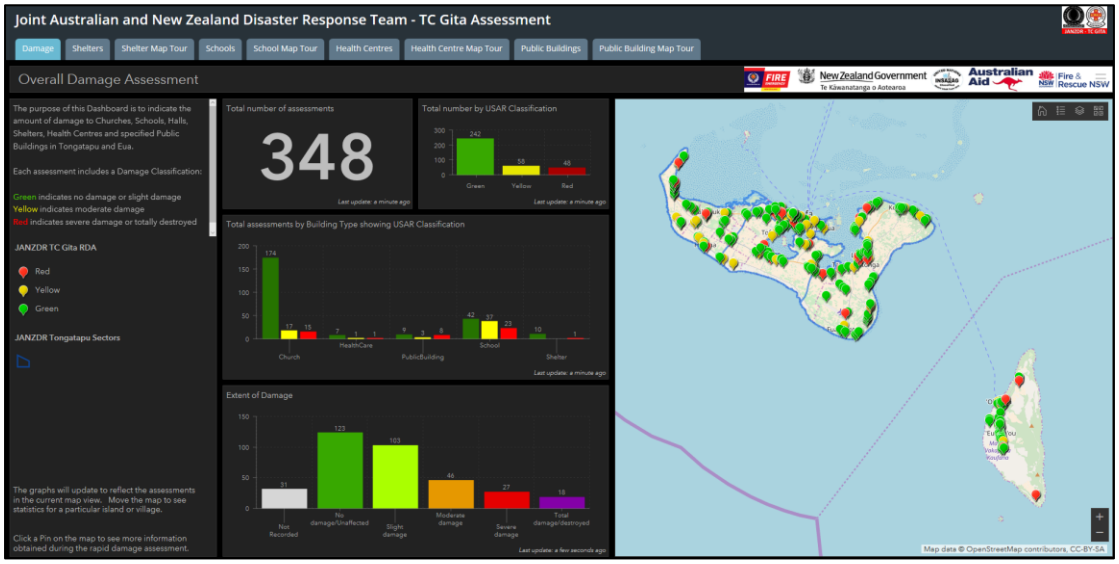
Briefing boards and dashboard must be easier to configure and produce

The ability to manage data to present collated information needs to be addressed

Challenges (technical)

- The growing dependency on cloud technology and services increases the need for reliable in-field comms
- Capability needs to be baselined but no two Events are the same. This makes it difficult to be 100% prepared and IT systems need to be agile and flexible
- Response teams have a wide range of skills. GEOINT needs to be a recognised function and staffed and supported appropriately
- Expectations for disconnected deployments and paper workflows need to be part of the GEOINT workflows

TC Gita Combined Dashboard (Showing Totals)



FUTURE STATE

From a Fire and Emergency NZ, position, the potential for mobile information systems to impact positively on operations is immense. The organisation has only really considered the high profile major event applications, yet these systems have immense value in day to day operations, from providing effective in field data collection processing for general business work, such as conducting Home Fire Safety Visits in communities, through to examples like the recent Ngongotaha flooding, where information was collected and displayed for local councils and Civil Defence in relation to damage and evacuation.

Within the USAR/DART scope, the ability to coordinate data through different systems and applications and being able to setup a system that is easy to replicate and deploy for international and domestic operations is a focus. Additionally, the development of reporting and briefing functions that again are easy to set up, able to be templated and deployed are areas are advantageous as Fire and Emergency NZ seeks to embed and be leaders in the Emergency Management Intelligence field.

The ability to capture and process information into intelligence will be a core focus of the organisation operationally as it develops capability with the RPAS and other sensors, it will need to develop the capacity and capability to ensure that the end products are able to deliver on the expectations and investment in technology.

From a process position, Fire and Emergency NZ will look to have an end to end solution that includes the ability to have platform independent collections systems, providing data streams that can be analysed and fed into a range of products, including tasking, reporting and resourcing. These systems will provide a wide range of situational awareness across the early stages of response through to downstream recovery. Provide decision makers in all phases effective intelligence to make effective decisions that provide positive outcomes to the victims of any disaster.

Importantly the ability to form relationships and partnerships with agencies of providers of GEOINT services is key to ensuring Fire and Emergency NZ can provide a future focused intelligence capability that will cover the broad scope of operations Fire and Emergency NZ is legislated for. To ensure that the contributions to communities both domestic and international is at the highest level and to further ensure the Fire and Emergency

NZ is representing both the organisation and New Zealand in a manner that enhances its ability to have a positive effect on the communities it serves.

CONCLUSION

The opportunities that exist in the GEOINT/Information management environment to produce effective intelligence is considerable. The ability to collect information from a range of sensors, (Drones, ground based collectors, existing information, crowd sourcing and the like) and to collate and display this information in targeted intelligence products will increase the effectiveness of response efforts. While there is significant potential in the current systems being used, there are some factors where the systems are not configured or designed to provide easy to use and replicable systems, without significant specialist input and effort.

A stretch goal perhaps would be to look to develop these attributes to achieve the above, with the current Esri based applications and programs proving an excellent platform to develop.

Operational experiences inform, that these products in play come very close to what is needed, it is in the detail that Fire and Emergency NZ seeks the final links and function to join up the missing pieces that take the current systems from marginal to outstanding. Devil is always in the detail.

In a world where disaster is becoming almost the norm, Fire and Emergency NZ is still in an evolving space in regard to the utilisation of different sensors (UAV, Field data apps, crowd sourcing) and the capture, management and development of intelligence products that can influence the outcomes of sudden onset disasters whatever their magnitude.

The Esri products provide an excellent platform on which to continue to build this capability and together with the GEOINT and a range of First responders all working in the same space, experience from with NZUSAR indicates that it is possible to advance the boundaries and develop these products to a point where they are intuitive and meet the broad range of requirements that currently exist, as Fire and Emergency NZ continue to respond to a wide range of disaster events, across a range of theatres.

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