

# Israeli Executions of Palestinian Aid Workers and Efforts to Conceal Evidence: Tel al-Sultan, Gaza Strip, 23 March 2025

Report by Earshot and Forensic Architecture

23 Feb 2026

*The findings, analysis, and conclusions presented are those of the authors.*



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## 1. INTRODUCTION AND CONTEXT

On 18 March 2025, airstrikes by the Israeli military broke the ‘ceasefire’ agreement of 17 January 2025 in Gaza, killing at least 414 Palestinians, including 174 children.<sup>1</sup> This renewed air assault continued throughout the following days.

On Sunday 23 March 2025, at 3:52, two Palestinian Red Crescent Society (PRCS)<sup>2</sup> ambulances were dispatched to the scene of an airstrike in al-Hashahin, near Rafah in the south of Gaza.<sup>3</sup> The first ambulance departed from the PRCS headquarters in Khirbet al-Adas, east of Rafah, with crew members Saleh Muammar, Raed al-Sharif and Ashraf Abu Libda (Ambulance A). The second departed from the British Field Hospital, west of Rafah, with crew members Mustafa Khafaja, Ezz El-Din Shaat and Munther Abed (Ambulance B).



Figure 1: Map showing the paths of Ambulances A, B, C, and D from their bases to the site of the airstrike in al-Hashahin.

At 3:55, Ambulance B lost contact with PRCS headquarters while driving south towards Tel al-Sultan, with its internal and external emergency lights on, and all crew members wearing official uniforms or volunteer vests. It was later discovered that, Ambulance B had come under direct fire near Tel al-Sultan, in an area hereafter referred to as the ‘incident site’, defined in our investigation as a stretch along Gush Katif Road, with a radius of approximately 200m departing from the site where Ambulance B was attacked and its journey aborted (Figure 1). As a result of the attack, crew members Mustafa and Ezz El-Din were killed.

<sup>1</sup> <https://apnews.com/live/latest-updates-israel-launches-new-wave-of-airstrikes-across-gaza-after-ceasefire-talks-stall#00000195-a988-d36f-a797-a99b37260000>; <https://www.amnesty.org/en/latest/news/2025/03/israeli-air-strikes-kill-over-400-palestinians-across-gaza-following-unilateral-resumption-of-mass-attacks/>

<sup>2</sup> PRCS is an internationally-recognised organisation which provides humanitarian assistance and health and social services to Palestinians. PRCS is a member of the International Federation of Red Cross and Red Crescent Societies. PRCS works towards preventing and alleviating human suffering, protecting life and health, ensuring the respect of human dignity, preventing disease, and promoting health and social care for Palestinians in times of peace and during emergencies, crises, and disasters.

<sup>3</sup> All times are given in a 24 hour-format (HH:MM).

While the fate of Ambulance B was still unknown, having completed its rescue mission at al-Hashashin, Ambulance A was dispatched towards the British Field Hospital to search for Ambulance B. Ambulance A was joined by two more PRCS vehicles: Ambulance C, with crew members Muhamad Bahloul and Muhamad al-Hila, and Ambulance D, with Asaad al-Nasasra and Refaat Radwan. This 'rescue convoy' located the missing Ambulance B at 4:39. The crew of Ambulance A used their radio to call for support, and two vehicles belonging to the Palestinian Civil Defence (PCD),<sup>4</sup> an ambulance and a fire truck, subsequently joined the convoy. All vehicles were clearly marked and had their emergency lights on. This convoy was also attacked upon its arrival to the scene shortly after 5:00.

Between the time of the attack on the convoy and 6:05, two UN vehicles, a Toyota Hilux and a minibus, had also passed by the incident site and been similarly attacked.

In total, fifteen Palestinian aid workers were killed by Israeli forces at the incident site on 23 March 2025. According to reports, some of the victims had been, shot 'execution-style' from close range.<sup>5</sup>

The victims were:

Mustafa Khafaja, ambulance officer, PRCS  
Ezz El-Din Shaat, ambulance officer, PRCS  
Saleh Muammar, ambulance officer, PRCS  
Refaat Radwan, first responder volunteer, PRCS  
Muhammad Bahloul, first responder volunteer, PRCS  
Ashraf Abu Libda, first responder volunteer, PRCS  
Muhammad al-Hila, first responder volunteer, PRCS  
Raed al-Sharif, first responder volunteer, PRCS

Zuhair Abdul Hamid al-Farra, fire truck driver, PCD  
Samir Yahya al-Bahapsa, firefighter officer, PCD  
Ibrahim Nabil al-Maghari, firefighter officer, PCD  
Fouad Ibrahim al-Jamal, ambulance driver, PCD  
Youssef Rassem Khalifa, ambulance officer, PCD  
Anwar al-Attar, ambulance officer, PCD

Kamal Mohammed Shahtout, UNRWA

Following the ambush, Israeli forces crushed all eight vehicles using heavy machinery, and attempted to bury them under the sand.

The body of Anwar al-Attar was found near the incident site on 27 March,<sup>6</sup> and the bodies of the other fourteen victims, all wearing identifying uniforms or volunteer vests of their respective organisations, were found in a mass grave near the site on 30 March.

<sup>4</sup> The Palestinian Civil Defence is a branch of the Palestinian Security Services, under the Ministry of Interior, that is responsible for emergency services, rescue, and protection of civilians and their property.

<sup>5</sup> <https://www.theguardian.com/world/2025/apr/02/evidence-execution-style-killings-palestinian-workers-israeli-forces-doctor-says>

<sup>6</sup> <https://www.france24.com/en/live-news/20250409-survivor-recounts-israeli-attack-in-gaza-that-killed-15-aid-workers>

On 28 March, after the discovery of al-Attar's body, the Israeli military admitted that its soldiers had fired on 'ambulances and fire trucks' (NB: our investigation indicated that there was only one fire truck present) after identifying them as 'suspicious vehicles'.<sup>7</sup> On 31 March, after the remaining bodies were discovered near the site, Israeli military spokesperson Nadav Shoshani claimed in a post on X that 'several uncoordinated vehicles were identified advancing suspiciously toward IDF troops without headlights or emergency signals'.<sup>8</sup>

On 2 April, Munther, one of the two PRCS crew members who had survived the attack, gave an interview to the BBC in which he reported that all of the vehicles in question had had their emergency lights on when they came under fire.<sup>9</sup>

Two days later on 4 April, the PRCS president reported in a press briefing that a video of the incident had been recovered from the cell phone of one of the murdered paramedics, and that he had presented it to the UN Security Council to increase pressure for an independent and thorough investigation.<sup>10</sup> The recording, which was published the same day by the New York Times (and the day following by the PRCS on their X account), showed that the vehicles in the convoy were clearly marked as emergency vehicles with their emergency lights on when they were fired upon without warning.<sup>11</sup> It also showed that a number of the victims had been wearing reflective high visibility uniforms at that time.

On 5 April, multiple media outlets reported on a briefing earlier that day at which a spokesperson for the Israeli military admitted that their earlier statement claiming that the emergency vehicles had approached with their lights off was inaccurate. Instead, the Israeli official claimed that soldiers had initially fired on a vehicle containing three Hamas members, and that the convoy of responding ambulances was perceived as a threat because it had stopped alongside said vehicle.<sup>12</sup>

Asaad, the other PRCS crew member who survived the incident, was abducted by the Israeli military immediately following the attack. His whereabouts had remained unknown to the PRCS until 14 April, when they were informed that Asaad was being held captive by the Israeli military.<sup>13</sup> He was released fifteen days later on 29 April 2025 in poor health after having been detained without charge for 37 days.<sup>14</sup>

On 20 April, the Israeli military announced that an internal inquiry into the incident had 'identified several professional failures' and 'breaches of orders'.<sup>15</sup> Its report denied that there had been 'indiscriminate fire' by soldiers, blamed the attacks on 'poor night visibility' and maintained that the

<sup>7</sup> <https://www.france24.com/en/middle-east/20250329-israel-admits-firing-ambulance-gaza-strip-palestine-red-crescent-rescue-amas-war-crime><https://www.france24.com/en/middle-east/20250329-israel-admits-firing-ambulance-gaza-strip-palestine-red-crescent-rescue-amas-war-crime><https://www.idf.il/en/mini-sites/idf-press-releases-israel-at-war/april-25-pr/the-incident-on-march-23rd-in-which-terrorists-abusing-medical-vehicles-were-eliminated-by-idf-troops/>

<sup>8</sup> [https://x.com/LTC\\_Shoshani/status/1906761462917247361?s=20](https://x.com/LTC_Shoshani/status/1906761462917247361?s=20)

<sup>9</sup> <https://www.bbc.co.uk/news/articles/ckgere1y740o>

<sup>10</sup> <https://webtv.un.org/en/asset/k16/k16lk6m1l3>, <https://www.youtube.com/watch?v=PP6UaHYp1QE>

<sup>11</sup> <https://www.nytimes.com/2025/04/04/world/middleeast/gaza-israel-aid-workers-deaths-video.html>,

<https://x.com/PalestineRCS/status/1908458778040631384>

<sup>12</sup> Some of the media outlets described that the Israeli military's insistence to some of the medics being linked to Hamas.

<https://www.bbc.com/news/articles/cy0xp969n69o>

<sup>13</sup> <https://x.com/PalestineRCS/status/1911354918893465820?s=20>

<sup>14</sup> <https://x.com/PalestineRCS/status/1917297485401186441>

<sup>15</sup> <http://www.idf.il/en/mini-sites/idf-press-releases-israel-at-war/april-25-pr/summary-of-the-examination-into-the-incident-involving-rescue-teams-and-vehicles-in-the-gaza-strip/>

incident had unfolded in a 'hostile and dangerous combat zone, under a widespread threat to the operating troops'.

Three days later, the Israeli version of Haaretz published an article claiming that the Israeli military's published report excluded key findings from its inquiry into the incident, among them that: on one occasion Israeli forces had indiscriminately fired at the aid convoy; the road along which the vehicles were attacked was designated safe for passage by rescue workers and civilians under the military's own regulations; the unit that had carried out the attack had explicitly been informed beforehand of increased ambulance traffic in the area; a reconstruction of the scene conducted with the commanding officer of the unit responsible for the attack revealed they would have clearly been able to see the flashing lights of the emergency vehicles from their position; and that one of the soldiers questioned an Arabic-speaking detainee about the identity of his colleagues and concluded, despite not speaking Arabic, that they were Hamas operatives.<sup>16</sup>

The claims and allegations of the Israeli report continue to be collectively rejected by PRCS, the United Nations Relief and Works Agency for Palestine Refugees in the Near East (UNRWA) , and the PCD service.

***Additional materials related to this investigation can be found at:***

<https://www.forensic-architecture.org/investigation/the-massacre-of-aid-workers-in-tel-al-sultan>

<https://earshot.ngo/en/investigations/israeli-executions-of-palestinian-aid-workers>

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<sup>16</sup> <https://www.haaretz.co.il/news/politics/2025-04-23/ty-article/.premium/00000196-5ee3-db89-a5d7-def3d6c70000>

## 1.2. Scope of Analysis

This investigation sought to draw on the combined expertise of Earshot and Forensic Architecture (FA), combining specialised audio and spatial analysis practices in order to map out the trajectory of the incident with unprecedented precision. The interplay between the two investigative practices allowed for a collaborative cross-exchange of evidence through which FA's initial reconstruction of the scene formed the basis for Earshot's echo analysis of the available audio recordings, which in turn allowed the precise location of the perpetrators to be determined and visualised.

Earshot and Forensic Architecture (FA) analysed media including: open-source images and videos, satellite imagery, and social media posts; PRCS video and audio recordings including phone calls and radio communications; official publications by the United Nations (UN), PRCS, other Palestinian civil society organisations, and international media; and statements by the Israeli military and Israeli military spokespersons.

FA and Earshot interviewed two survivors of the attack, employing 'situated testimony' interview methods [see section 4 on methodology] to bring greater resolution to the digital reconstruction of the scene and events surrounding the massacre.

The aim of the study was to:

- 1.2.1 Establish the circumstances and sequence of events according to available audiovisual and written evidence and the testimonies of survivors.
- 1.2.2 Examine, interrogate, and where necessary challenge and correct the description of the massacre offered by the Israeli military, international media, and the UN.
- 1.2.3 Determine the position of Israeli military personnel in relation to the aid workers and vehicles during the incident, and the potential lines of sight of those personnel.
- 1.2.4 Trace the transformation of the incident site in the hours and days following the attack.

## 2. MATERIAL USED IN THE ANALYSIS

The investigation by FA and Earshot examined the following materials:

- 2.1. 'Situating testimony' interview with a PRCS volunteer and witness to the attack, Munther Abed, conducted on 21 May 2025.
- 2.2. 'Situating testimony' interview with a PRCS paramedic and witness to the attack, Asaad al-Nasara, conducted on 30 June 2025.
- 2.3. Two videos from 23 March 2025 recovered from the mobile phone of the paramedic Refaat Radwan.
- 2.4. Video recordings from 23 March 2025 of a call between Asaad al-Nasara and PRCS dispatch.
- 2.5. Audio recording from 23 March 2025 of a call between Ashraf Abu Libda and PRCS dispatch.
- 2.6. Autopsy reports of the victims Ashraf Abu Libda, Refaat Radwan, Muhammad al-Hila, Muhammad Bahloul, and Mustafa Khafaja.
- 2.7. Audio recordings and written documents from PRCS's internal investigation, recording the sequence of the incident according to call timecodes and the testimonies of PRCS dispatchers.
- 2.8. Video from 27 and 30 March 2025 published by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) documenting the exhumation of bodies at the site.
- 2.9. Satellite imagery from Planet Labs PBC (16, 18, and 26 March; 25 April; 30 May; 26 June; 11 and 18 July; 29 August; and 12 September 2025) and Airbus Defence and Space (23 March 2025).
- 2.10. Video from 10 June 2025 showing civilians at a Gaza Humanitarian Foundation (GHF) 'aid distribution' site.
- 2.11. Written report from 16 September 2025 by United Nations Human Rights Council (HRC) titled 'Legal analysis of the conduct of Israel in Gaza pursuant to the Convention on the Prevention and Punishment of the Crime of Genocide'.

### 3. SUMMARY OF FINDINGS

Earshot and FA's investigation offers detailed evidence regarding the circumstances of the incident on 23 March 2025 in Tel al-Sultan, including extrajudicial executions, a survivor being forced to work at an Israeli military checkpoint, and efforts to conceal, disturb, and erase evidence relating to the attack.

Our investigation demonstrates the following:

- 3.1. Israeli soldiers ambushed and subjected Palestinian aid workers to continuous assault by gunfire for over two hours, between 5:09 and 7:13. There was no exchange of fire in the area, and no tangible threat to the safety of those soldiers. These attacks did not happen in 'a hostile and dangerous combat zone', as was claimed by Israeli spokespersons.<sup>2</sup>
- 3.2. At least 910 gunshots were documented across the three recordings from the night. The majority of these gunshots, at least 844, were captured in Refaat Radwan's video, all fired within a five-and-a-half-minute period.
- 3.3. At least 93% of the gunshots fired by the Israeli soldiers were fired directly towards the emergency vehicles and aid workers during the first five-and-a-half minutes of the attack. During this time, at least five shooters fired simultaneously, and witness testimonies suggest as many as thirty soldiers were present in the area.
- 3.4. Israeli soldiers were positioned on high ground by the road on which the victims' vehicles travelled, with no obstructions limiting the line of sight of the soldiers. The emergency lights and markings of the victims' vehicles would have been clearly visible to the soldiers at the time of the attacks.
- 3.5. The soldiers advanced on the aid workers and the ambulances while shooting. Upon reaching them, they moved through the vehicles and shot several of the aid workers at close range.
- 3.6. At least 8 gunshots were fired from positions in-between the emergency vehicles. One of these gunshots was fired from within one to four metres of Ashraf Abu Libda's position. The timing of those shots coincided with the last time his voice was heard in recordings from the night, strongly suggesting that these were the shots that killed him.
- 3.7. One of two PRCS survivors of the attack was later used as a 'human tool' at an Israeli military checkpoint near to the incident site.
- 3.8. Israeli military personnel acted intentionally to conceal and disrupt evidence of the attack by:
  - 3.8.1. Burying the bodies of the victims;
  - 3.8.2. Burying the mobile phones of at least one of the victims;
  - 3.8.3. Crushing and partially burying the victims' vehicles;
  - 3.8.4. Transforming the site with earth-moving vehicles in the hours immediately following the attack;
  - 3.8.5. Detaining one of the witnesses to the attack (see 3.12).
- 3.9. The intentional concealment and disruption of evidence involved, among others, soldiers named Elias, Yotam, and Amatzia.
- 3.10. The earthworks carried out at the site in the hours after the attack transformed the incident site into an evacuation route. Two checkpoints were established near to the incident site, and a series of earth berms were built and later used for holding and interrogating Palestinians passing through the checkpoint.

- 3.11. Between 23 March and 30 May 2025, the area surrounding the incident site was further transformed by the Israeli military's construction of the 'Morag' corridor and the erection of an aid distribution site operated by the Gaza Humanitarian Foundation (GHF).
- 3.12. In the 37 days following the attack, one of the two survivors of the attack was detained without charge, tortured, and interrogated in relation to the incident at the Sde Teiman detention camp.

## 4. METHODOLOGY

The objective of this work was to digitally reconstruct the scene of the shooting, encompassing the landscape, built structures, vehicle positions, individuals shown in Refaat's video, and the location of the recording devices present at the scene.

FA conducted GIS analysis, site modelling, and photomatching to produce a 3D reconstruction of the scene. This site model was used by Earshot to conduct audio analysis, including echolocation, audio ballistic analysis, and spectral enhancement.

In addition, Earshot and FA also interviewed two survivors of the attack employing the technique of 'situated testimony', which informed both the spatial reconstruction and audio analysis.

### **Notes:**

All times in this report use 24-hour clock format (e.g., 14:30)

The area referred to as the 'incident site', is a stretch along Gush Katif Road, with a radius of approximately 200m departing from the site where Ambulance B was attacked and its journey aborted (Figure 1).

### **4.1. GIS analysis**

We compared satellite imagery from before and after the incident to map the transformation of the landscape and Israeli military activities in the area, including the destruction of buildings, construction of earth berms, and the emergence of a GHF site on the same land. Some of these features were then mapped onto the site model developed.

### **4.2. Site modelling**

A site model of approximately 1.4 km<sup>2</sup> was created, comprising the landscape, structures, and vehicles in proximity to the site of the shooting.

It began with a digital surface model (DSM) with a spatial resolution of 30m, sourced from [ALOS World 3D](#). This was used to generate a topological model of the area within the 3D software [Blender](#). Satellite imagery covering the same spatial extent was applied to the surface model. This enabled all structures present at the site to be accurately positioned (Figure 2).

Building heights were calculated using the sun position calculator [SunCalc](#). Knowing the precise time each satellite image was taken, and therefore the relationship between structure height and shadow projection, we were able to calculate the height of each structure present on the site. To corroborate the height calculations, this process was repeated using multiple satellite images captured at different times of day.

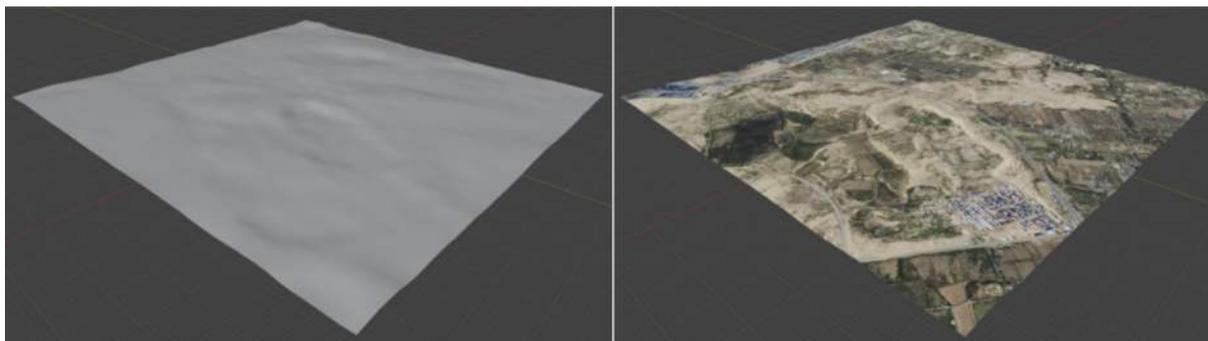


Figure 2. Initial site model derived from an ALOS World 3D DSM (left), and projected with a satellite image of the same extent (right).

### 4.3. Photomatching

Photomatching is the process of reproducing a physical camera inside a digital reconstruction, in order to spatialise the information contained in a photograph. A camera's position, angle, and focal length are calculated inside the 3D scene. As a result, the elements within a photograph can be replicated in the correct position and scale within the frame.

In the process of modelling the site, photomatching was used to add detail to, and corroborate, the landscape features, to map the approach and final position of vehicles present at the scene, and to position individuals and the recording device used.

#### The landscape

Photographs taken in daylight, during the recovery of the victim's bodies on 27 and 30 March 2025, were used for the identification of small hills, shear geometry, and pits that were not captured by the coarse resolution of the original DSM (Figure 3).



Figure 3. The photomatch of an image captured on 30 March 2025 (left), with the landscape model (right). This enabled the earth berms identified in satellite imagery to be mapped in the model at accurate heights.

#### The convoy approach

In the video recorded by Refaat, capturing the minutes before and after the shooting began, we observe five vehicles moving in convoy, and one vehicle already parked. As the video progresses, we were able to garner information about the location of these vehicles as the shooting began, which was then photomatched with the site model to track their movement through the scene and their final positions.

The vehicle which was already present at the site ('Ambulance B') is a Toyota Hiace with a rear emergency light. It is seen parked throughout the recording. The mapped location of Ambulance B is confirmed.

The first two vehicles in the convoy, a 2003 Chevrolet Express PRCS-marked ambulance ('Ambulance A') and a fire truck ('PCD fire truck') of unknown model are observed stopping, and their occupants exiting 12 minutes and 22 seconds into the video. The mapped locations of Ambulance D and the PCD fire truck are confirmed.



Figure 4. Photomatch 13 minutes 22 seconds into Refaat's recording, showing Ambulance A, B, and the PCD Fire Truck having come to a stop. The PCD Ambulance is still in motion at this point.

The vehicle from which the footage was recorded, identified as a Toyota Hiace PRCS-marked ambulance ('Ambulance D'), parks during the recording. Ambulance D stops at 13 minutes and 32 seconds; its approximate position was determined based on the camera's location at that time (Figure 4). The mapped location of Ambulance D is highly likely.

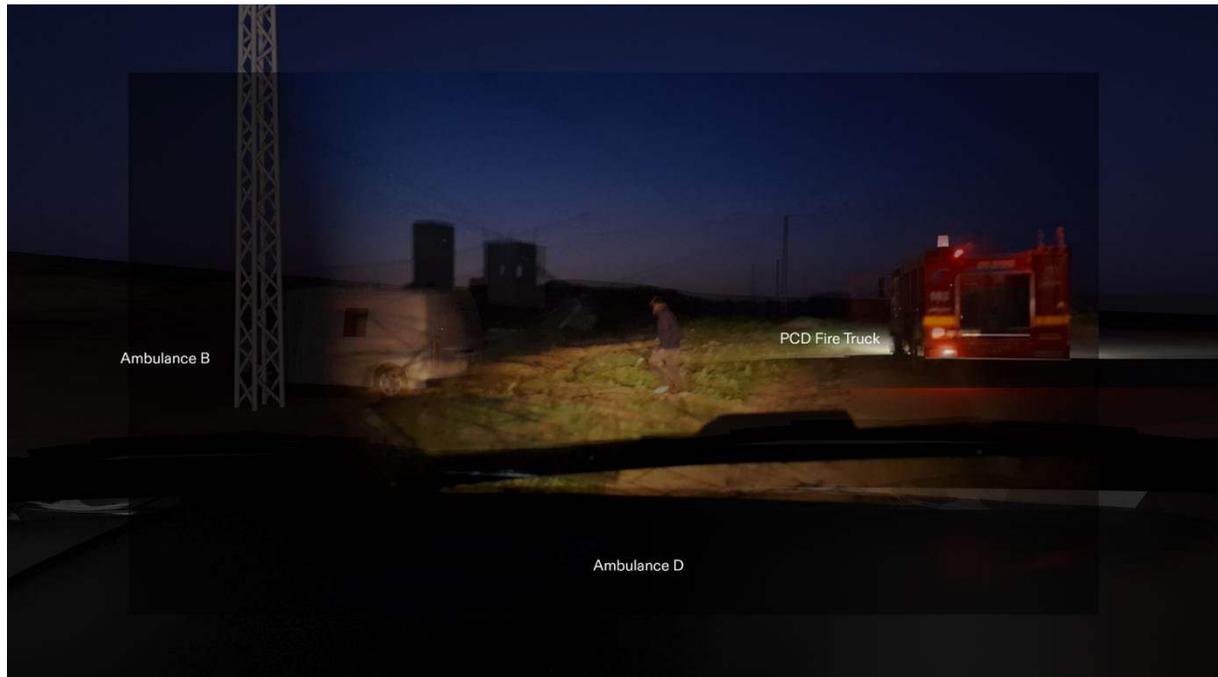


Figure 5. Photomatch with a frame 13 minutes 32 seconds into Refaat's recording. Ambulance D, the vehicle from which the recording was captured, has come to a stop.

Two other vehicles were part of the convoy. One vehicle, a Toyota Hiace PRCS-marked ambulance belonging to the Civil Defence ('PCD Ambulance'), is last seen in the video at 13 minutes 27 seconds before leaving the frame (Figure 6). By then, it has slowed significantly and likely stopped soon after. This is corroborated by Asaad's situated testimony. The mapped location of the PCD Ambulance is approximate.

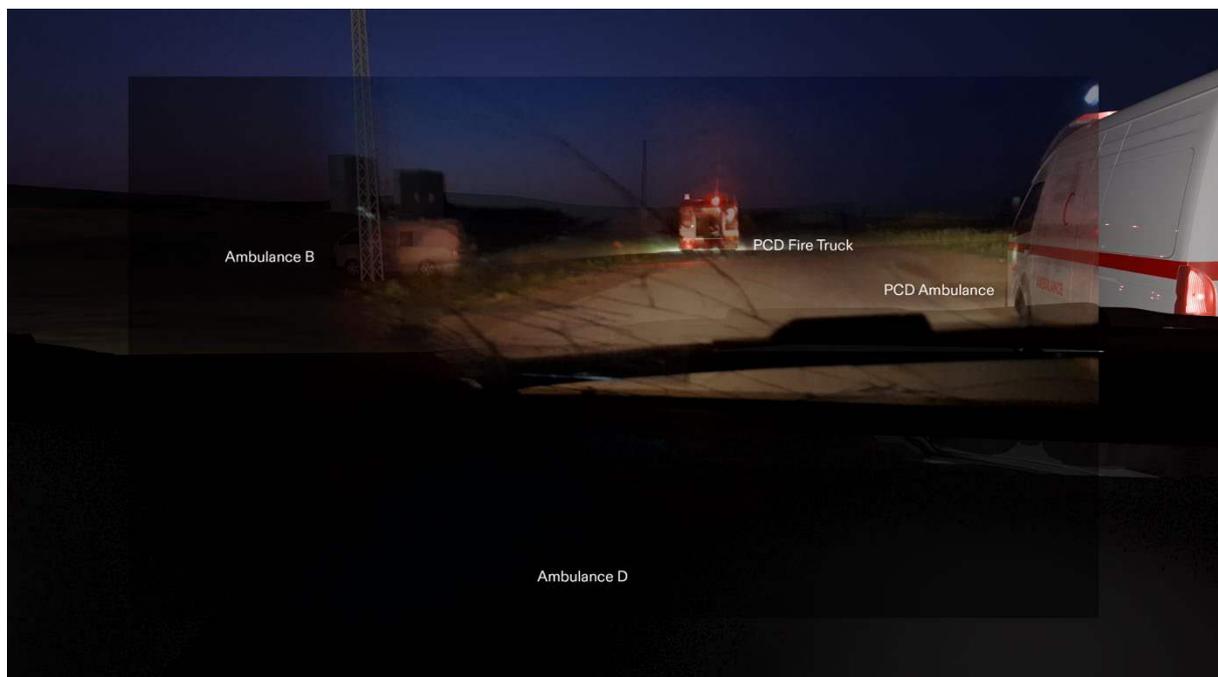


Figure 6. Photomatch with a frame 13 minutes 27 seconds into Refaat's recording. This is the last clear frame where we see the PCD Ambulance, which has slowed significantly by this point.

The final vehicle in the convoy, identified by Asaad as a PRCS-marked 2003 Chevrolet Express ('Ambulance C'), is not seen within the frame as it is always behind Ambulance D —the vehicle from which the recording is taken. This vehicle was positioned based on Asaad's recollection of the night and aligned with the vehicle he was travelling in (where the video recording was taken), positioning it approximately 3.5 metres behind Ambulance D (Figure 7). The location of Ambulance C is approximate.



Figure 7. The final position of each ambulance as the shooting began.

### The position of people and Refaat's recording device

Moments after the shooting begins, a frame of Refaat's recording shows him passing in front of Ambulance D, followed by two separate frames in which his phone is facing Ambulance D, the vehicle from which he exited; in one of these frames, the front bumper is visible (Figure 8). This allowed us to assess Refaat's movement at the time of the shooting and his position during most of the gunfire, forming the basis of the subsequent audio reconstruction.

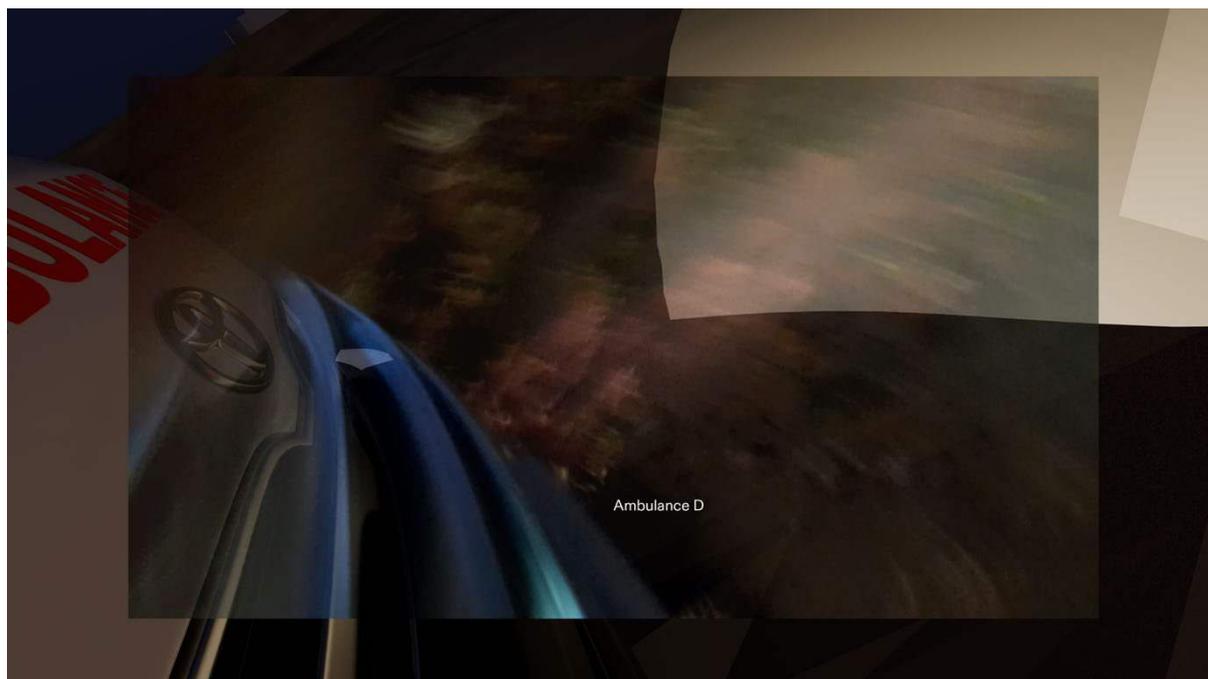


Figure 8. Photomatch taken shortly after shooting began, showing that Refaat passed in front of the vehicle he was occupying.

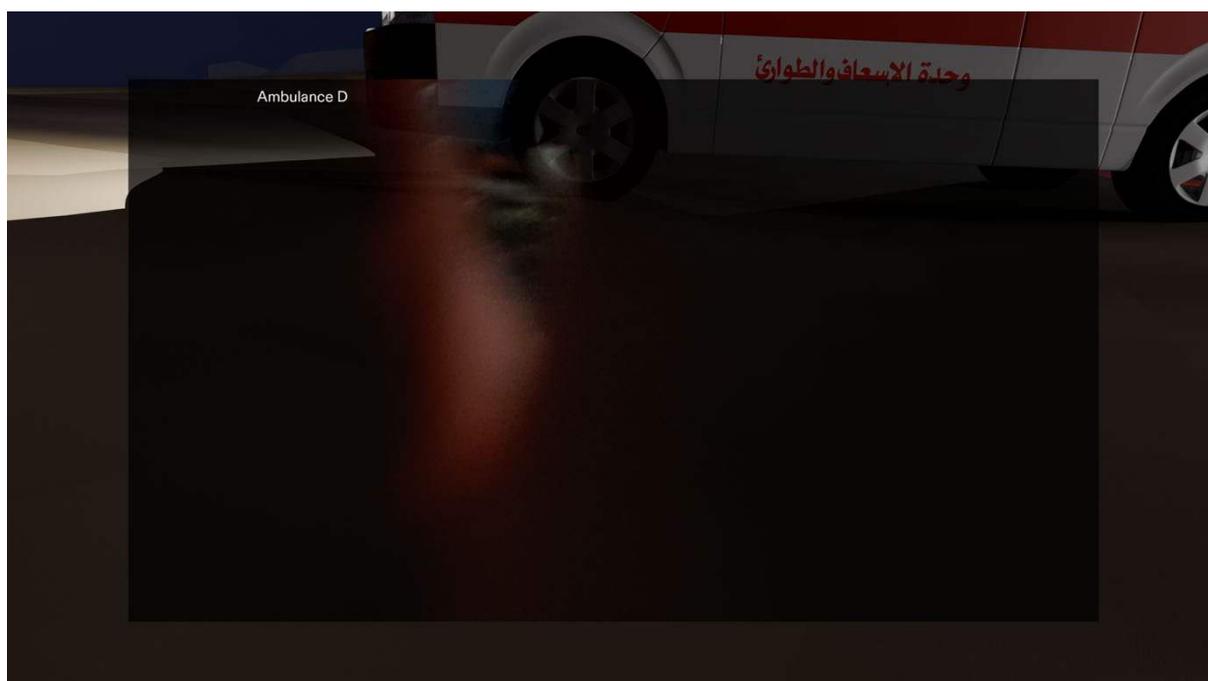


Figure 9. Photomatch of a partial view of Ambulance D, showing a wheel and the front of the vehicle.

Each relevant frame was reproduced within the model using a camera with a focal length of 28 mm (36 mm sensor). This focal length was determined because it produced imagery that aligned with the relative positions of vehicles, landscape features, and structures already identified within the model (see above). It is therefore highly likely that this setting replicates the camera parameters of Refaat's phone. This approach allowed us to analyse the spatial relationship between the camera and scene elements, even in frames with limited visual information, such as Figure 9, in which only the front wheel of the ambulance is visible.

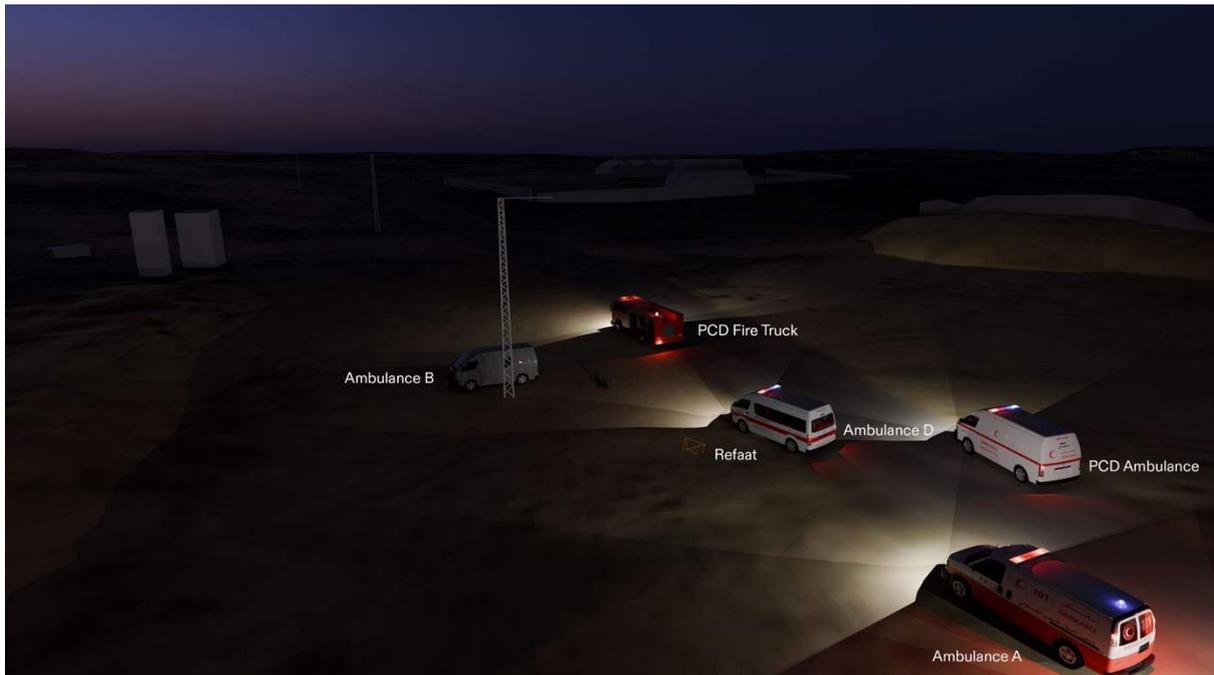


Figure 10. The final position of all vehicles in the scene, including Refaat's position in relation to Ambulance D, as identified in the photomatches above. This is the approximate location from which most of the gunfire in Refaat's recording was captured.

#### 4.4. Situated testimony

The site model was used by Earshot and FA, in collaboration with the PRCS, to facilitate the process of gathering situated testimony, and to corroborate the situated testimony alongside public testimony sourced from social media and news outlets.

Situated testimony employs 3D models of the scenes and environments in which traumatic events occurred to support the process of interviewing and gathering testimony from witnesses. By placing witnesses within fixed and known spatial positions, the method assists them in filling in key gaps in their recollection of what they saw and heard. This approach is based on the understanding that positioning witnesses within 3D representations of the locations they occupied during an incident can facilitate more accurate and detailed recall.

Earshot and FA conducted two situated testimony interviews remotely on 21 May 2025 and 30 June 2025 with Munther Abed and Asaad al-Nasasra, respectively. A member of the PRCS, Ali Jallad, was also present during both interviews. An Arabic-speaking member of FA helped conduct the interviews. These testimonies responded to the site model, adding further resolution to the data analysed from the video footage and enabling an understanding of the movements of individuals and vehicles where visual information was not available. One key outcome of this process was the determination of Asaad and Ashraf's positions throughout the night. Given that during the incident both had made calls to the PRCS, which we obtained, understanding their positions during these calls in relation to other elements in the scene became critical for Earshot's audio analysis of the scene.

#### 4.5. Audio analysis

The audio analysis was done by Earshot. Earshot analysed the audio from three recordings: a six minute video captured by PRCS paramedic Refaat Radwan taken at 5:09; a one minute and 37 second recording of a phone call between PRCS paramedic Ashraf Abu Libda and the PRCS headquarters taken at 5:14; and a series of five clips taken from a recording of a phone call between PRCS paramedic Asaad al-Nasara and the PRCS headquarters at around 6:55, totalling 8 minutes and 40 seconds.

Earshot's audio analysis involved echolocation, audio ballistic analysis, and audio enhancement. Earshot used these methods to corroborate several witness statements on the positions and movements of the Israeli soldiers throughout the attack, as well as to provide additional information on the timeline of the attack, and the names of three of the Israeli soldiers.

#### 4.5.1. Echolocation

Echolocation, in this context, is the process of using the propagation of sound waves and their acoustic reflections to forensically reconstruct a scene or event. The time delay, direction, and distortion of the echo reveal the size, distance, texture, and shape of objects in the environment. This process allows Earshot to estimate the position of a sound source and its movements. Earshot identified patterns of echoes in the gunshots captured in Refaat Radwan's video and Ashraf Abu Libda's phone call.

A 3D reconstruction of the site during the attack was provided by FA. From the 3D reconstruction, Earshot identified the surfaces causing the echoes. Earshot used 2D and 3D software, namely Rhinoceros, Grasshopper and Blender to calculate and simulate the behaviour of sound travelling through the site and reflecting to the camera as an echo.

This process allowed Earshot to estimate the most likely area where gunshots with audible echoes were fired from. To simulate the behaviour of sound, its dissipation across space, and its reflections in the form of echoes, Earshot gathered all the necessary variables within a reasonable threshold of certainty, such as the speed of sound based on the temperature at the time of day.

#### 4.5.2. Audio ballistic analysis

Audio ballistic analysis looks at the constituent sounds that make up the sound of a gunshot. These constituent sounds each inhabit unique frequencies in the audible frequency range and contain crucial information, such as the trajectory of gunfire in relation to a recording device, as well as the distance between the shooter and the recording device.

Earshot identified the constituent sounds of a gunshot by analysing the spectral imagery of the recordings on the audio analysis software iZotope RX.<sup>17</sup> Earshot marked all the relevant sounds of gunfire in iZotope RX's 'txt' marking system.<sup>18</sup> Once all the constituent sounds of gunfire were identified, Earshot used standard equations in audio ballistics to derive the distance of the shooter from the recording device.<sup>19</sup> Earshot gathered all the necessary variables such as the speed of bullets fired from the weaponry that Munther Abed witnessed being used by the Israeli military. All calculations were derived within a reasonable threshold of certainty.

<sup>17</sup> Spectral imagery is a visualisation of individual frequencies in an audio recording.

<sup>18</sup> Files available upon request.

<sup>19</sup> These equations were taken from existing literature such as Chapter 9 from Robert Maher's 'Principles of Audio Forensic Analysis'.

Earshot's investigative practice includes the visualisation of sonic phenomena, such as that of supersonic weaponry, as a means of communicating its methodology and findings. These visualisations were done using a bespoke, node-based script made by Earshot on Grasshopper.<sup>20</sup>

#### **4.5.3. Spectral enhancement**

Spectral enhancement is the process of removing unwanted noise from an audio recording with the aim of clarifying the desired content. This was conducted in Refaat Radwan's video to enhance the sound of the movement of an emergency vehicle during intense gunfire, as well as in Asaad al-Nasasra's phone call to identify the content of speech between Israeli soldiers. This enhancement was done using iZotope RX through a combination of manual techniques, such as low pass filters or manual selection and removal of frequencies, and through machine learning plugins native to iZotope RX such as 'de-noise'.

Earshot adheres to strict protocols of transparency and accountability. All of Earshot's findings were derived through traceable and repeatable methods of analysis.

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<sup>20</sup> This script is available upon request.

## 5. FINDINGS

### 5.1. The early stages of the ambush

On Sunday 23 March 2025, at 3:52, two PRCS ambulances were dispatched to the scene of an airstrike in Tel al-Sultan, near Rafah in the south of Gaza (Figure 11). The first ambulance departed from the PRCS headquarters in Khirbet al-Adas, east of Rafah, with crew members Saleh, Raed, and Ashraf (Ambulance A). The second ambulance departed from the British Field Hospital, west of Rafah, with crew members Mustafa, Ezz El-Din and Munther (Ambulance B).

Ambulance B had its internal and external lights on throughout its journey, and all crew members were wearing PRCS uniforms or identifying insignia.



Figure 11: Satellite map, showing the path of PRCS Ambulances A and B in relation to the site of ambush and the site of the airstrike in the al-Hashashin area.

At 3:55am, Ambulance B lost contact with PRCS headquarters. According to Munther's testimony, it came under direct fire while driving south.<sup>21</sup> Mustafa and Ezz El-Din who were in driver and passenger seats were injured because of the shooting. Mustafa lost control of the vehicle, which veered left and stopped near an electricity pole.

Extract from the testimony of Munther:

<sup>21</sup> Testimony of survivor Munther: 'We were given a call dispatch that an attack had taken place in al-Hashashin neighbourhood, in Rafah. At that time, we were travelling from Khan Younis towards Rafah, from north to south. We were on the move at around dawn, so we had both our internal and external lights on. As we were travelling, we were suddenly struck by intense gunfire.'

*'The ambulance stopped due to the intensity of the gunfire... you could smell the burning of the engine [which was] on fire because of the shooting. When the shooting started, everything in the ambulance went out. The lights, the sound of the motor, everything.'*

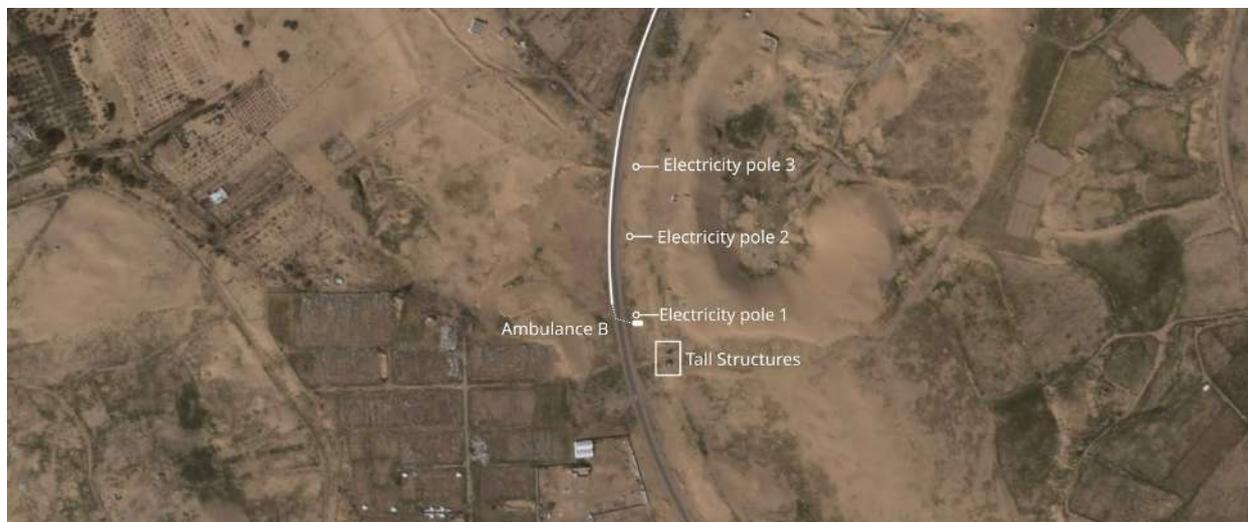


Figure 12: Map showing the location of the ambulance before it was brought to stop by intense fire.

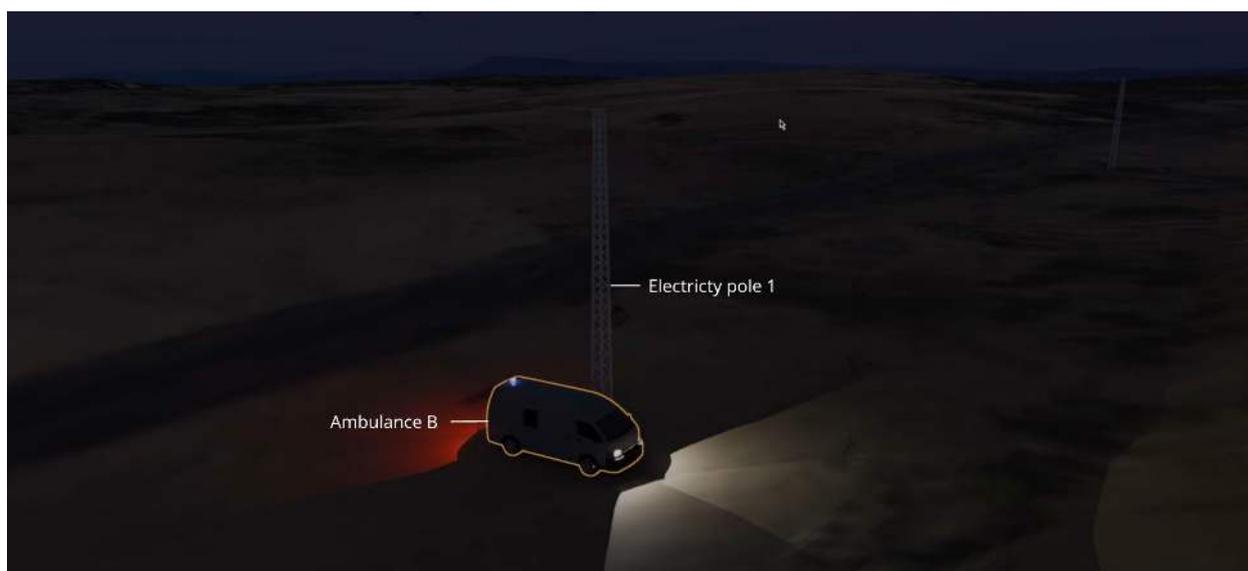


Figure 13: Image looking south, showing the location of the ambulance when it was brought to stop by the utility pole.

When the shooting ceased, Israeli soldiers approached from the right side of Ambulance B, arrested Munther, and detained him in a nearby 'pit.' Sometime later, two Palestinian civilians—a father and son from the Bardawil family—who were also detained by Israeli soldiers, were brought to the pit (Figure 14).<sup>22</sup>

The Israeli soldiers took the three detainees further away from the road to an elevated area behind a tall concrete structure, where a further group of soldiers was positioned. A pit and two nearby

<sup>22</sup> Testimony of Munther: 'At that point, I was the only person in the pit. Later on, they seized two civilians and put them in there—two members of the Bardawil family, a big man and his son. That was it, there wasn't anyone but us three.'

structures are visible in a satellite image of the incident site dated 16 March. According to the testimony of Munther, there were more than a dozen soldiers in the vicinity.

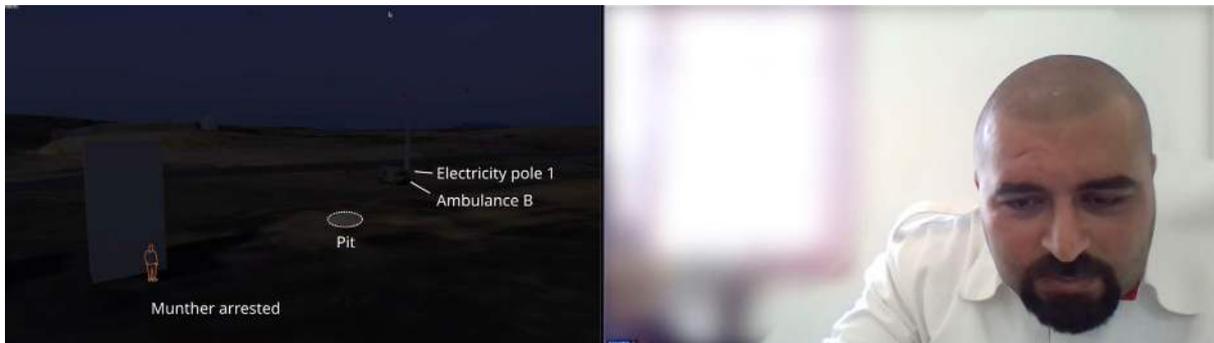


Figure 14: Still from the situated testimony with Munther showing the location of the pit and the tall buildings where he was taken when arrested.

Having completed its rescue mission at al-Hashashin, Ambulance A was instructed at 4:35 to search for Ambulance B. It successfully located Ambulance B at 4:39 and radioed for support. Two more PRCS ambulances, with crew members Muhammad Bahloul and Muhammad al-Hila (Ambulance C), and Asaad and Refaat (Ambulance D), were dispatched from the PRCS headquarters in Rafah towards the location of Ambulances A and B.

From 4:55, Refaat in Ambulance D captured video recordings on his phone which confirmed the route that Ambulances C and D took to the incident site.

Refaat's footage showed that at 5:01, Ambulance D approached Ambulance B from the south, and passed by it without stopping, the driver and passenger seemingly having not noticed it (Figure 15). Ambulance D did not come under attack at this time.



Figure 15: Annotated still from video taken by Refaat shows Ambulance B in the dark, while Refaat and Asaad approach and pass it from the south at 5:01. The drivers did not notice Ambulance B at this time. Left: original still from footage, right: still with added brightness.

At 5:02, Ambulances A, C and D met at a roundabout. After exchanging information, the convoy proceeded to the ambush site. Asaad was the driver of Ambulance D and Saleh the driver of Ambulance A.

The following dialogue was captured in the video recorded by Refaat:

*Asaad: Abu Yousef, how are you guys?*

*Saleh: I saw one leg under the ambulance.*  
*Asaad: One of your guys?*  
*Saleh: Yea. Didn't you see the ambulance on your way?*  
*Asaad: No, I didn't see any ambulance.*  
*Saleh: You didn't see it?*  
*Asaad: No, where is it?*  
*Saleh: How could you not see it?*  
*Asaad: I didn't see the ambulance.*

At 5.07am, the Ambulances A, C, and D were joined by two PCD vehicles, including an ambulance and a fire truck, and continued driving towards Ambulance B from the north. The first vehicle of the convoy—the PCD fire truck with crew members Zuhair, Samir, and Ibrahim—arrived on the scene at 5:08. It was then followed in order by: PRCS ambulance A, crewed by Salah, Raed, and Ashraf; PCD ambulance crewed by Fouad, Yousef, and Anwar; PRCS ambulance D crewed by Refaat and Asaad; and PRCS ambulance C crewed by Muhammad Bahloul and Muhammad al-Hila (Figure 16, Figure 17).



Figure 16: Annotated video footage shows the arrival of the convoy to the incident site.



Figure 17: Position of all vehicles at the incident site at 5:10.

The digital reconstruction of the scene also shows that any soldiers positioned near the structure(s) referred to in Munther's testimony would have had an uninterrupted view of the arrival of the convoy (Figure 18). Munther described seeing the emergency lights of the convoy as they approached. The soldiers observed were kneeling and aiming their weapons at the convoy as it approached.<sup>23</sup>

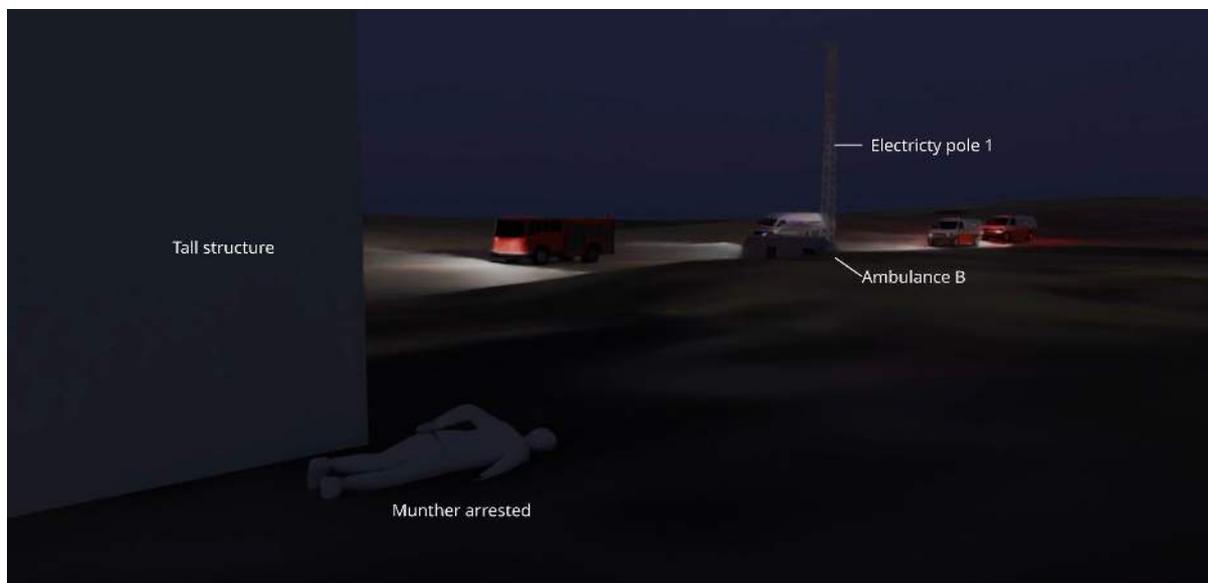


Figure 18: Locations of Munther and the soldiers who detained him, relative to the convoy of ambulances. From their position, the soldiers would have been able to clearly see the convoy's arrival, with their emergency lights on.

## 5.2 Ambush and execution of aid workers

<sup>23</sup> Testimony of Munther: 'The only thing I could make out were the lights of the ambulances. I was lying down flat, and they put an M16 rifle on my back. I was surrounded by soldiers. When the cars arrived, they got orders to fire from above my back, directly at the convoy. My face was facing the other way entirely. We stayed on the ground, and they put M16s on our backs. The soldier behind me was giving the orders. While they were kneeling with their guns, they opened fire all together - it was intense.'

Video evidence shows the vehicles parking one-by-one near Ambulance B at 5:08, over a period of nineteen seconds. According to Munther's testimony, as the aid workers left their vehicles and began approaching Ambulance B by foot, the Israeli soldiers opened fire on the convoy.<sup>24</sup>

Extract from the testimony of Asaad:

*'As soon as the gunfire started, it hit my ambulance first - that of me and Refaat. We're talking about a matter of seconds, here... I saw the member of the civil defence, he had fallen on his stomach on the floor, and he was already dying. Refaat had fallen, Ashraf had fallen, the whole team from the civil defence [had fallen].'*



Figure 19: Annotated still three seconds before the start of the shooting, from video taken by Refaat.

When the first shots were fired at 5:09, Refaat held his phone to his chest and shielded it with his hand. Seven seconds into the shooting, the figure of Asaad is visible in the resulting footage, seen between Refaat's fingers as he held the phone. Asaad identified himself in this video still (Figure 20, Figure 21) during interview.

<sup>24</sup> Testimony of survivor and PRCS paramedic Asaad: 'When we arrived, and stopped [...] I braked the car, opened the door and got out. We both got out immediately. As soon we were out of the car they started shooting.'



Figure 20: Situated testimony of Asaad where he recognises himself hiding by the ambulance in a still from Refaat's video. The 3D model on the left shows a 'photomatch' of the still within the 3D model.

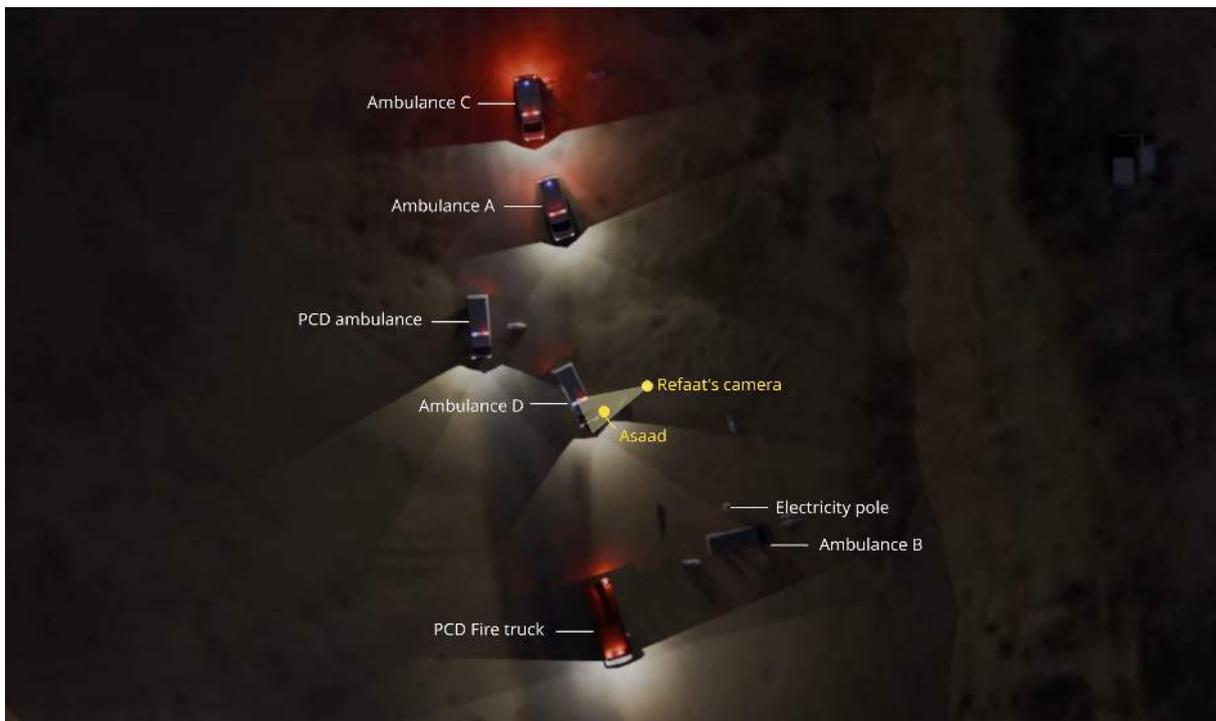


Figure 21: Plan view of the 3D model showing the position of Refaat and Asaad at 5:09.

Refaat continued recording for five minutes and thirty seconds after the start of shooting. At least 844 gunshots were fired in this time. An audio ballistic analysis of these 844 gunshots established that Refaat's camera was consistently in the line of fire throughout the period of audible gunshots. Earshot identified the sound of a supersonic bullet shockwave, made by the bullet flying past the camera, followed by the sound of the muzzle blast in 789 out of the 844 gunshots, indicating at least 93% of gunfire was fired towards the emergency vehicles ([appendix paragraph A.1.1](#)).



Figure 22 (A8): 3D visualisation of remaining surfaces (blue) on the site, and the 2-metre concrete wall most likely causing the muzzle blast echoes heard on Refaat’s video.

Earshot was able to confirm the presence of at least five shooters firing simultaneously. At minute 01:25:457 in Refaat’s video, Earshot identified five gunshots fired in 67 milliseconds. 67 milliseconds is the shortest possible rate of gunfire for the weaponry identified by Munther as having been used by the Israeli soldiers on the night. This suggests at least five shooters were present, firing simultaneously. However, these findings do not exclude the possibility that there were many more than five shooters at the scene: both Asaad and Munther testified that the number was much higher, with Asaad saying there were ‘at least twelve soldiers,’ and Munther saying there were ‘at least thirty’ stationed where he was held. ([appendix para. A.1.2](#)).

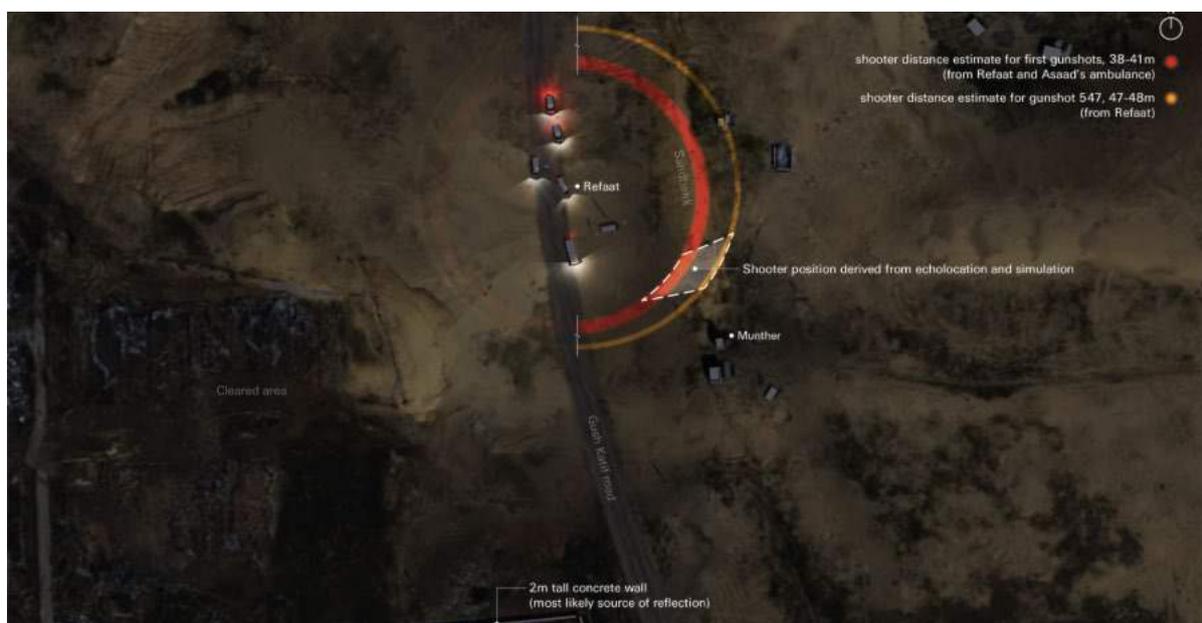


Figure 23 (A9): White-dashed outline likely position of the Israeli soldiers for the first 4 minutes of Refaat’s video, derived from an analysis of muzzle blast echoes and from the interval between supersonic bullet shockwaves and muzzle blasts.

Audio ballistic analysis ([appendix para. A.2.1.1](#)) and echolocation confirmed the soldiers’ initial positions on an elevated sandbank 38 to 48 meters southeast of the vehicles. Echolocation is the

process of locating the source of a sound based on an analysis of the sound's echoes and the environment in which the sound travels. The Israeli army's destruction and clearance of Tel al-Sultan meant that very few structures remained. This fundamentally changed the area's acoustic behaviour. This destruction has paradoxically strengthened Earshot's ability to determine the positions and movements of Israeli soldiers based on identifying the surfaces responsible for clearly distinguishable gunshot echoes. In the first four minutes of gunfire these echoes are audible between 558 and 603 milliseconds after the muzzle blast. Earshot identified a two-metre-tall and fifty-metre-wide concrete wall 130 metres south of Refaat as the only surface capable of causing these echoes. Echolocation confirmed the position of the Israeli soldiers on an elevated sandbank southeast of Refaat ([appendix para. A.2.1.2](#))

The interval between the muzzle blast and the echo remains stable between 558 to 603 milliseconds in the first four minutes of gunfire. This suggests the Israeli soldiers remained stationary on the elevated sandbank while firing continuously for these four minutes ([appendix para. A.2.1.3](#)). This analysis confirms the location where Munther Abed testified being held at gunpoint, surrounded by Israeli soldiers who opened fire towards the vehicles, as the convoy arrives.

At 5:10, 44 seconds after the shooting began, the PCD ambulance attempted to depart the scene. According to Asaad's testimony, the vehicle came under intense gunfire and was quickly brought to a stop, as the driver was shot and killed (Figure 24). Audio ballistic analysis confirms Asaad's testimony and indicates that the PCD ambulance was brought to a stop in under eight seconds (Figure 25).

Extract from the testimony of Asaad:

*'And I was exactly [here] at this point....the [engine of the] vehicle was still on, even though the driver was dead at the wheel, and it struck the bank and the wheels kept turning.'*

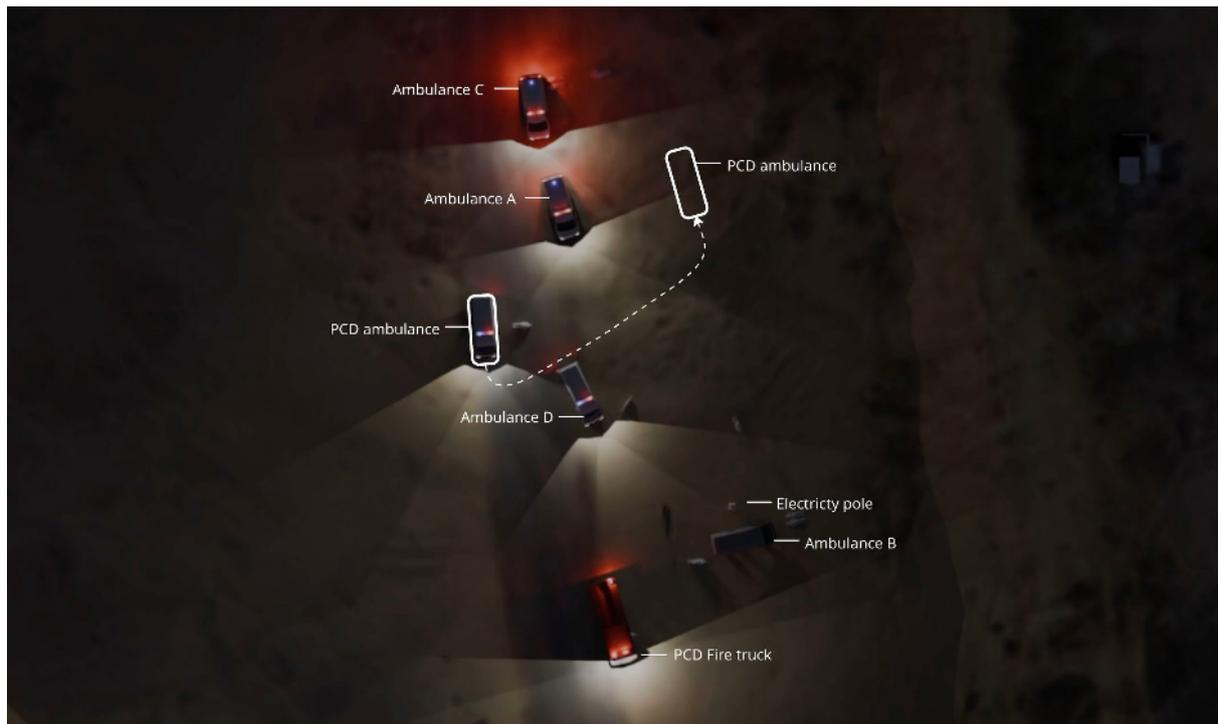


Figure 24: Annotated 3D model showing the escape attempt by the PCD ambulance based on situated testimony of Asaad.

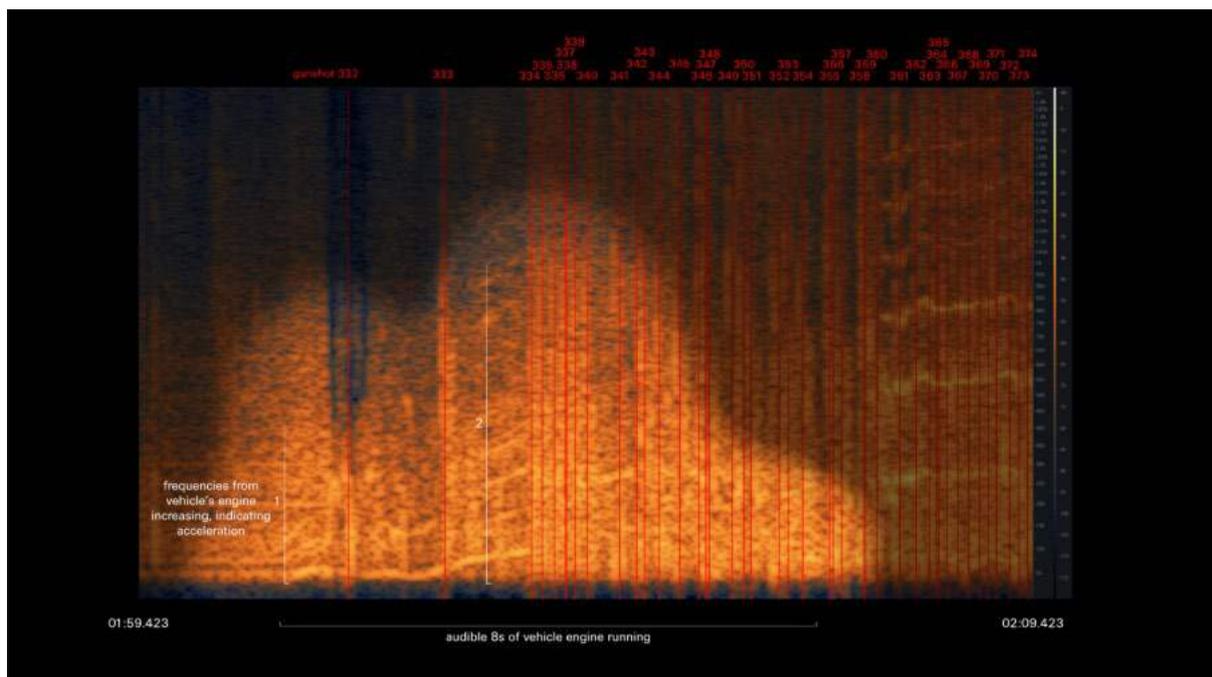


Figure 25 (A10): Spectrograph of vehicle movement audible in Refaat's video, 44 seconds after the first gunshot.

According to his testimony, during the first five-and-a-half minutes of shooting, Asaad crawled towards to Ambulance C, where two of his colleagues – Muhammad Bahloul, and Salah – had taken refuge (see Figure 26). As he approached the ambulance, he realised that Muhammad Bahloul had been killed,

and Saleh was badly injured. Muhammad al-Hila, another colleague was crawling behind Asaad, and upon reaching him the two men embraced. Muhammad al-Hila was killed while they embraced.<sup>25</sup>

Extract from the testimony of Asaad:

*‘I went and I took Muhammad al-Hila in my grasp, and I put him on top of me, so that we would die together. I put my face to the ground and lay down. Mohammed got up, raised his body from the ground, and fell on top of me and he was killed on top of me. The last moment was his face on mine, and I called to him, “Ya Mohammed,” But he said nothing. Then I knew that he had been killed.’*

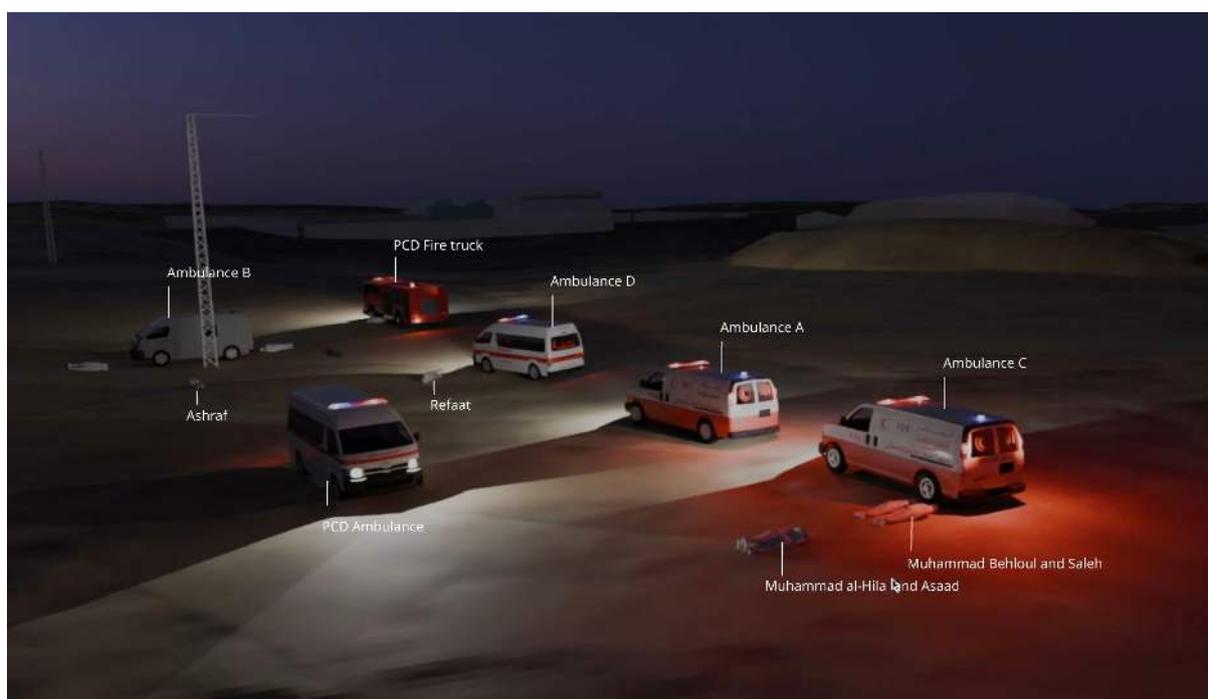


Figure 26: Annotated 3D model showing the location of Asaad and Muhammad al-Hila.

According to Asaad, as dawn broke the soldiers advanced towards the aid workers from behind a hill in a coordinated effort, speaking to one another in Hebrew.<sup>26</sup>

In the final one minute and thirty seconds of Refaat’s video, echolocation ([appendix para. A.2.2.1](#)) and audio ballistic analysis ([appendix para. A.2.2.2](#)) indicate that the soldiers moved towards the aid workers at a walking pace of approximately 1 metre per second while continuously shooting (Figure 27). This confirms Asaad’s testimony.

<sup>25</sup> Testimony of Asaad: ‘I kept crawling towards Saleh, and I saw the last car, of Mohammed and Mohammed. The guys were behind the wheels at the back of the car, hiding under there, holding each other: Muhammad Bahloul and Saleh Muammar. I went to crawl towards them, but I turned and came behind their ambulance itself. When I’d got about a metre away from Saleh, perhaps a metre, maybe a little more, the shooting became really intense at our position. At this point, Saleh was injured, and I think Muhammad [Bahloul] was killed. He was hit in his head, God rest his soul.’

<sup>26</sup> Testimony of survivor and paramedic with PRCS, Asaad: ‘They were coming down from the hill, talking in a specific Hebrew accent saying “we are advancing”. As they advanced, they were speaking together. I looked up and saw soldiers at the position where Mustafa was, holding him by the shoulders, picking him up with his legs and another soldier was taking pictures with a phone, or a camera or something, photos of Mustafa.’

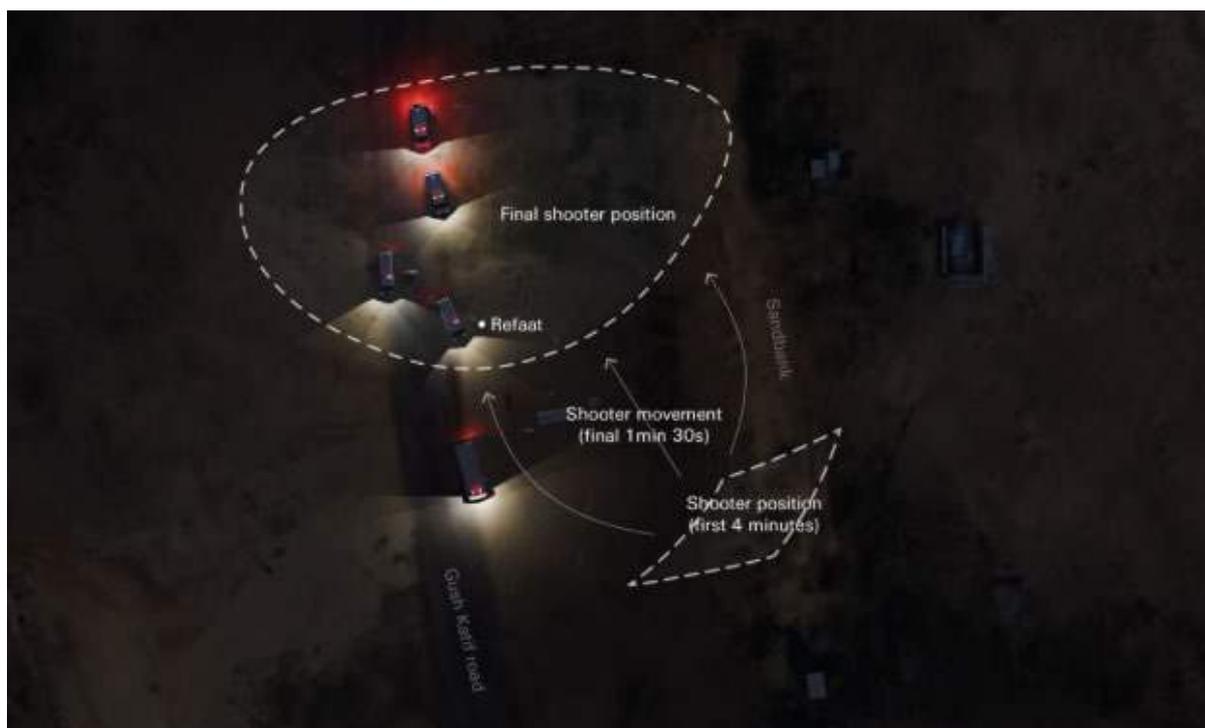


Figure 27 (A12): Map illustrating likely shooter movements and final position based on a simulation of muzzle blast echoes between 774 to 779 milliseconds, identified in the final 5 gunshots in Refaat's video.

At approximately 5:13, Ashraf called the PRCS headquarters. Earshot confirmed that Ashraf's phone call overlapped with the final 42 seconds of Refaat's video by synchronising the sound of 109 gunshots across the two recordings ([appendix para. A.2.3.1](#)) (Figure 28). These gunshots coincide with audible voices of Israeli soldiers, heard across the left and right audio channels in Refaat's video. This is the first time in the recordings where we hear voices speaking Hebrew at this level of intelligibility. Moreover, it is the first time we hear those voices distinctly separated across the stereo field, meaning that the Israeli soldiers are positioned to both the left and right of Refaat's telephone. In stereo recordings, proximity magnifies the positional differences captured by the left and right microphones. At a distance sound waves hit both microphones at roughly the same time and level. However once up close any slight movement of the source causes larger differences in arrival time and volume between the two channels, making the movement through the stereo field sound more pronounced and distinguishable. Therefore, the presence of the soldiers' voices heard both louder and across both left and right recording channels strongly suggests that Refaat had become surrounded by Israeli soldiers who were positioned in close proximity to him ([appendix para. A.2.3.2](#)). The audible presence of Israeli soldiers' voices coincides with Refaat and Ashraf's final words announcing the arrival of the Israeli soldiers. ([appendix para. A.2.3.3](#)).

Beyond establishing proximity through voices, Earshot's analysis of gunshot echoes in Ashraf's phone call provides further evidence of the shooters' positions. After Refaat's video ends, Ashraf's phone call continues for another 52 seconds, capturing 24 new gunshots. Eight of these gunshots contain new muzzle blast echoes, characterised by two to three echoes in quick succession, between twenty and 140 milliseconds after the muzzle blast. Analysis of these echoes concludes that they are reflecting off

surfaces three to 24 metres from Ashraf's phone. The only surfaces within 24 metres that could have caused these acoustic reflections were the emergency vehicles themselves. This strongly suggests that the shooters were firing from in between the vehicles, within metres of the aid workers ([appendix para. A.2.3.4](#)).

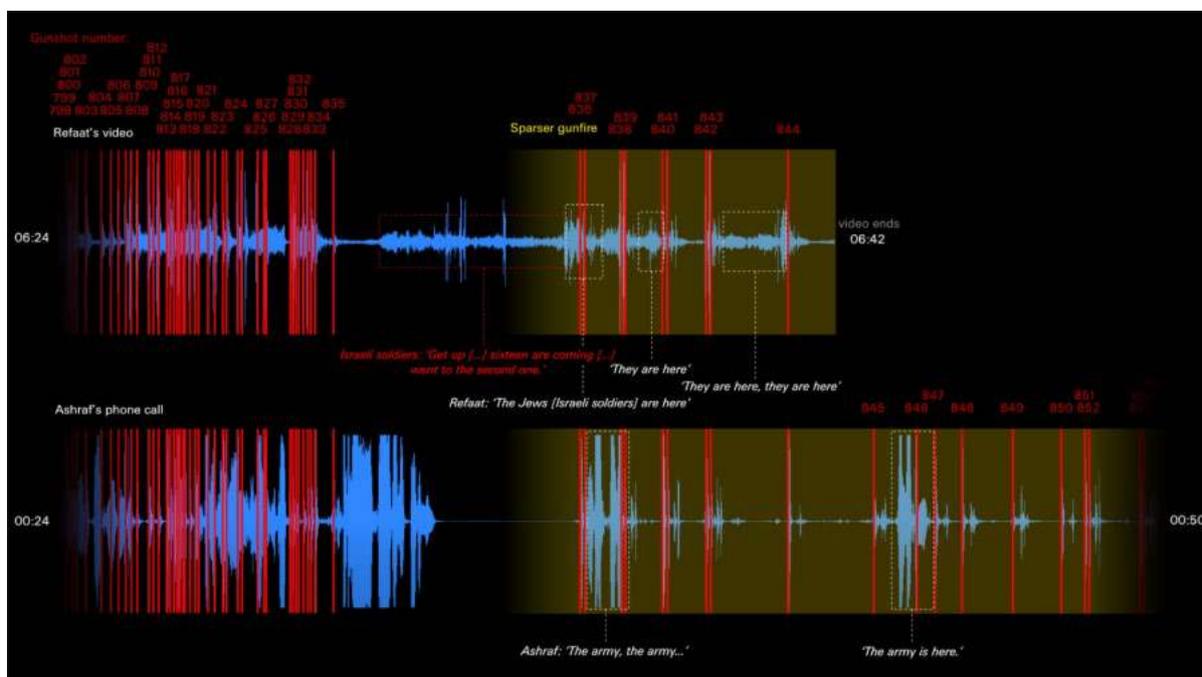


Figure 28 (A15): Synchronised audio from Refaat's video with Ashraf's phone call highlighting Refaat's and Ashraf's final words among the sound gunshots and approaching Israeli soldiers shouting military commands in Hebrew

Moreover, for three of the gunshots captured in Ashraf's phone call, Earshot was able to use the positions of the ambulances in relation to Ashraf's location to echolocate the position of the shooters more precisely. Earshot concludes that one of these gunshots was fired from within one to four metres of Ashraf's position at the time (Figure 29). These gunshots coincide with the last time we hear Ashraf's voice, suggesting these are most likely the gunshots that killed him ([appendix para. A.2.3.5](#)).

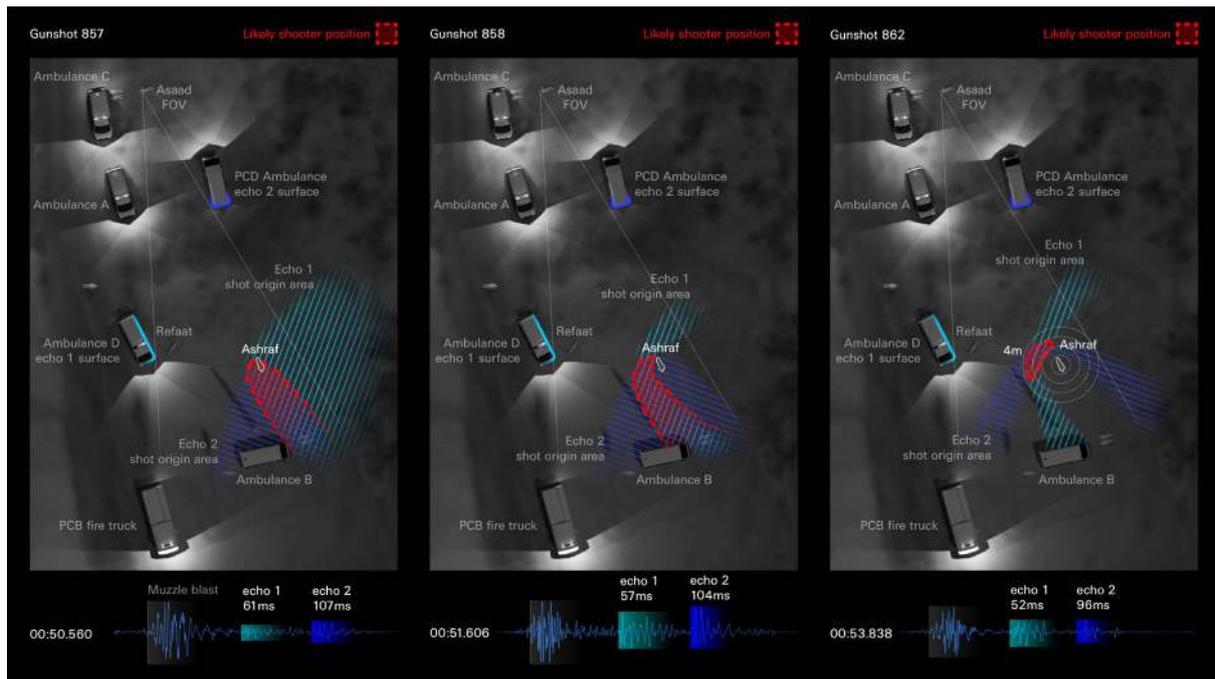


Figure 29 (A18): Echolocation of likely shooter area for gunshots 857, 858 and 862. (appendix para. A.2.3.5)

The echolocation evidence, the audio ballistic analysis ([appendix para. A.2.3.6](#)), and the intelligible Israeli soldiers' voices all corroborate Asaad's eyewitness testimony that Israeli soldiers 'came down [from the sandbank], got close to them [aid workers] and shot them from close range', and 'were walking between them [aid workers] and shooting.'

The gunshots recorded towards the end of Ashraf's phone call become less frequent than those preceding. According to autopsy reports, Refaat was shot in his head, while Muhammad Bahloul and Ashraf were shot in their chest. A doctor who examined the bodies reportedly described the 'specific and intentional location of shots at close range' as indicative of an 'execution-style' shooting.<sup>27</sup>

<sup>27</sup> <https://www.theguardian.com/world/2025/apr/02/evidence-execution-style-killings-palestinian-workers-israeli-forces-doctor-says>

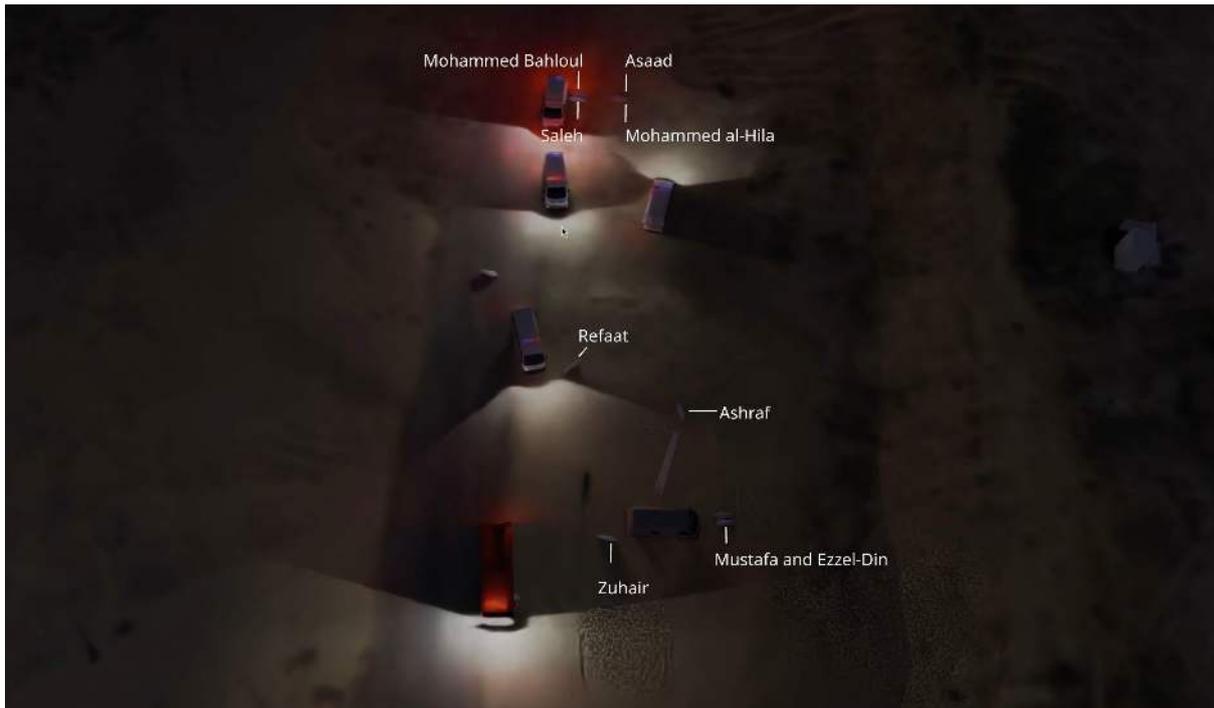


Figure 30: Annotated 3D model showing the position of crew members between 5:13 and 5:15.

The sunrise on 23 March 2025 in Gaza was at 5:42. According to Asaad, a Toyota Hilux clearly marked as a UN vehicle arrived on the scene after sunrise, driving from south to north. The vehicle was fired upon, and the UN lost contact with it at 6:00. Asaad described the position of the Toyota when it was brought to a stop, as well as the location at which the body of the driver, Kamal, fell to the ground (Figure 31).<sup>28</sup>

<sup>28</sup> Testimony of Asaad: 'When I saw the scene in front of me, I was scared. The jeep of the UNRWA came to a halt and I heard the sound, I didn't want to look up, I thought it was a Hummer. I made it look like I was dead. When I looked up I saw the army inspecting this vehicle to check that the driver was dead. They looked in the boot inside too. They took stuff from the boot - a bag, something 25 kilos or like that, I don't know what was inside it. He walked off with it in his hand and left. When they took me from this place, that's when I saw, in the middle of the road, someone in civilian clothing and a winter jacket of the UNRWA agency. In the middle of the road.'

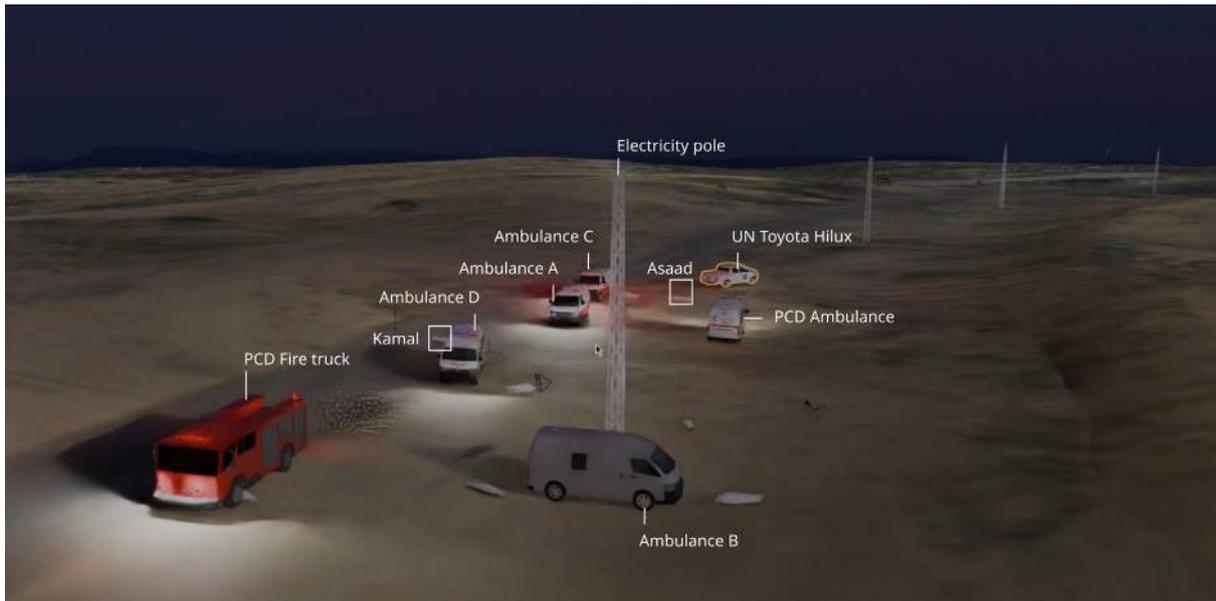


Figure 31: Annotated still from the model showing the position where the UN Toyota was brought to a stop, as well as the location where its driver Kamal was shot and fell on the ground.

Reports suggest that a second UN vehicle, a minibus, approached from the south and arrived at the scene at 6:05, and was brought to a stop by gunfire 220m to the north of the site of the ambush. This is also visible in satellite imagery a few hours after the ambush, at 11:00 (Figure 32, Figure 33). The driver was able to escape the scene. Asaad's testimony also refers to this UN vehicle.



Figure 32: Annotated 3D model showing the position of the UN minibus when it was brought to a stop.



Figure 33: Annotated 3D model showing the position of two UN vehicles in relation to Ambulance B and the convoy of emergency vehicles (Ambulance A, C, D and the PCS ambulance and fire truck).

Between 6:55 and 7:13, over two hours after the attack on the convoy, Asaad made a phone call to the PRCS headquarters which captured at least 42 additional gunshots and the sound of vehicle movement. Within this same recording, Earshot identified the sound of an explosion that matches the three-phased operation (ejection, ignition, and propulsion) of a Spike LR guided missile. This weapon is fired from a ‘vehicle-mounted’ or ‘man-portable’ missile launcher and is produced by Israeli defence contractor Rafael Advanced Defence Systems ([appendix para. A.2.4.1](#)). The use of a man-portable missile launcher by an Israeli soldier was also described in Assad’s testimony ([appendix para. A.2.4.2](#)).

Extract from the testimony of Asaad:

*‘The soldier was part of a different group in front of the cars, on one knee. Same position, holding the RPG launcher. In front of the cars, on the way from the Baraksat. There’s a small hillock there. He was positioned on one knee like you would to shoot the thing.’*

Earshot enhanced the audio from Asaad’s phone call to the PRCS headquarters at 6:55. Earshot could identify multiple voices of Israeli soldiers speaking in Hebrew. From these voices, Earshot could identify three names: Elias (nicknamed Lalas), Yotam and Amatzia ([appendix para. A.2.4.3](#)).

Asaad was captured sometime after this call and recounted the soldiers confiscating and burying his phone:

*‘When a soldier came towards me, I thought that’s it, he’s going to shoot me, he held his gun towards my head. The distance between us was perhaps two metres, he was really close to me. When he got close to me, I saw his head and*

*we looked each other in the eye, and I spoke to him in Hebrew - I said, "My mother is Israeli," and he immediately dropped his weapon. His colleague too. They got me to my knees. Mohammed fell to the side as I got up. Muhammad Bahloul was dead. Salehlaid where he was, he couldn't speak any more, So the soldiers took my phone, buried it in the sand - the soldier did it himself.'*

The audio analysis from the recordings on the night revealed that aid workers were directly and continuously attacked for over two hours. Earshot's detailed reconstruction outlines the unfolding of the attack, where Israeli soldiers first maintained fixed firing positions, then advanced while simultaneously shooting, and ultimately executed aid workers at close range. The names of soldiers involved in this incident should be used to advance efforts to hold those responsible for this attack accountable.

Audio evidence corroborated survivor testimonies in detail – from the soldiers' initial positions on the sandbank to their final movements among the emergency vehicles. This establishes the survivor accounts as accurate and reliable documentation of what occurred that day.

### **5.3 Detention, a 'human tool', and attempts to conceal, disturb, and erase evidence**

At 8:31 local time, four-and-a-half hours after the first of the emergency vehicles came under attack, an evacuation order was issued by the Israeli military via X for the residents of Tel al-Sultan.<sup>29</sup> An area that included the incident site was designated a 'dangerous combat zone' by a military spokesperson, who also specified that vehicles were prohibited from travelling through it. On 31 March, a different military spokesperson referred back to this designation, justifying the attack by claiming that the targeted vehicles had been 'uncoordinated' and operating in a 'dangerous combat zone', stating 'when terrorists act in an active combat zone, we will do whatever it takes to protect our civilians and troops'.<sup>30</sup> However, at no point during the attack – which lasted from 3:55 when Ambulance B first came under fire through to the assault on the emergency convoy which began at 5:09 – was the incident site publicly designated as a dangerous combat zone, nor would it have required coordination to pass through. On 25 April, the Israeli military issued another statement, this time using the evacuation order as a pretext for having moved the bodies and vehicles: 'At dawn, it was decided to gather and cover the bodies to prevent further harm and clear the vehicles from the route in preparation for civilian evacuation'.<sup>31</sup>

Around 9:00, leaflets were dropped from the air describing a specific evacuation route, which ran directly through the incident site towards the al-Mawasi area (Figure 34).<sup>32</sup>

<sup>29</sup> <https://x.com/AvichayAdraee/status/1903696196587180347?s=20>

<sup>30</sup> [https://x.com/LTC\\_Shoshani/status/1906761462917247361](https://x.com/LTC_Shoshani/status/1906761462917247361)

<sup>32</sup> <https://t.me/rafah1sultan1/382346>

<sup>32</sup> <https://t.me/rafah1sultan1/382346>



Figure 34: Flyer dropped from air showing the Israeli ordered evacuation route (left), and the evacuation route (right) marked in yellow, compared to the site of the incident enclosed by two blockades (marked in white).

A satellite image from 10:48 in the morning of the ambush shows that extensive earthworks were carried out at the incident site.<sup>33</sup> All emergency vehicles together with one of the two UN vehicles appear gathered in one spot and no human body is visible. The image also reveals the construction of an earth berm approximately 220 metres north of the location where one of the UN vehicles was brought to stop. The remains of the vehicle appear amongst these berms. Another earth berm is visible roughly 410 metres to the south of the incident site. These two positions later functioned as checkpoints, restricting access and controlling passage along the newly established evacuation route.

The earthworks visible in this image from 10:48 were not present at 5:09 when the shooting began. As the convoy approached the site, Refaat's video captures the ground conditions on both sides of the road. A still frame from this footage, matched into the 3D model, shows no evidence of the berms at that time (Figure 35). This finding corroborates the testimonies of both Munther and Asaad, who stated that the berms were constructed later that morning.



Figure 35: The 3D model comparison shows that the earth berms seen in satellite imagery in morning of 23 March 2025 (right) were absent when Refaat's video was filmed ten hours earlier (left).

Evidence of earthworks continue on site in the weeks following (Figure 36, Figure 37).

<sup>33</sup> The satellite image referenced was used to conduct analysis for the purposes of this report, but has not been included here due to Airbus licensing restrictions.



Figure 36: Satellite image from 26 March 2025, showing the scene of the incident in its aftermath, including blockades at north and south, and several earth berms in the middle. (Source: Planet Labs PBC)



Figure 37: Satellite image from 26 March 2025 showing earth berms to the north of the site (left) and to the south (right). (Source: Planet Labs PBC)

According to their testimony, Asaad and Munther were detained within one of these earthworks sometime that morning. Asaad described that location during his 'situated testimony' interview, as well as the conditions to which the two men were subjected while held there (Figure 38, Figure 39).

Extract from the testimony of Asaad:

*'It was super cold weather, 23rd March, it was super cold. Munther had his coat done right up to the top and he looked in a really bad way. He was shaking. I was cold too, and a soldier told me to put on this jacket, then he told me to turn around, and he tied up my hands. We stayed there on the*

*ground, tied up, tired, scared, with the cords cutting into our wrists in the dirt.'*



Figure 38: Satellite image from 26 March 2025 showing enclosures built by earth berms around the site of the massacre. Marked in white is the interrogation 'pit' where Asaad and Munther were held. (Source: Planet Labs PBC)

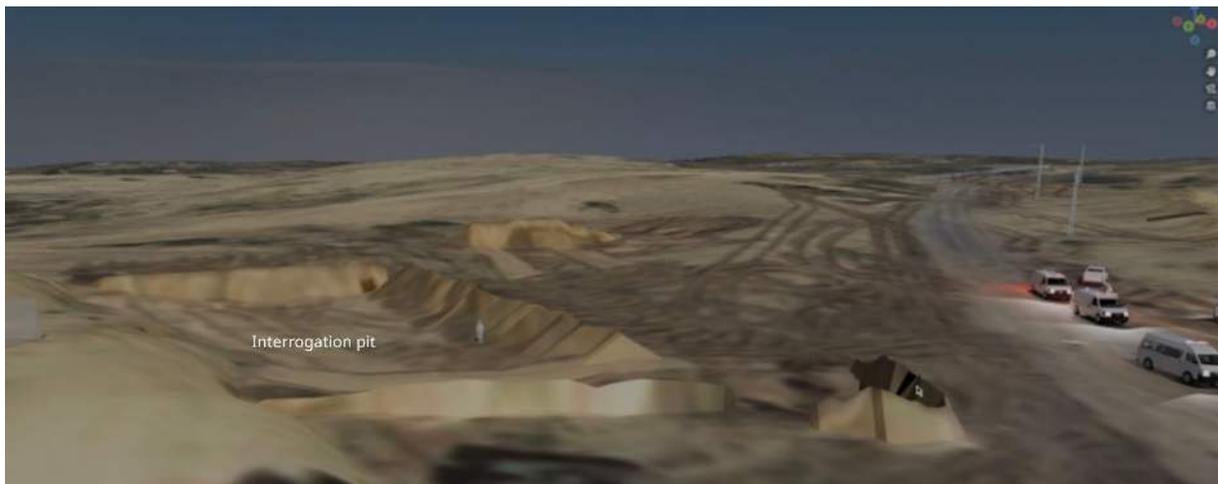


Figure 39: Still from the 3D model showing the interrogation pit, consisting of newly constructed earth berms, where Asaad and Munther were held.

Around midday, Munther was forced by Israeli soldiers to work at a checkpoint (likely the south blockade marked in Figure 37): separating men and women, and further separating those wanted for

interrogation into the newly built pits.<sup>34</sup> Munther's testimony to injuries endured by civilians passing through the checkpoint coheres with other accounts of violence and detention of civilians by Israeli personnel in this area.<sup>35</sup>

Testimony of Munther:

*'... of course, anything they wanted to check, they used me to do that. They were using me as a human tool. They weren't the ones to go up to people, they made me do it. I was made to do the inspections and tell the people to put their things down, stand up like this. I had to ask them, "what do you have with them," and tell the officer.'*

By assigning Munther to carry out inspections, the Israeli military forced a civilian to carry out a military objective and interposed him between soldiers and the civilian population, a practice which may meet the definition of 'human shield'.

Around the time of sunset at 17:52, Asaad was taken along with several other civilians through the Philadelphia corridor to Karam Abu Salim crossing. He was transferred to Sde Teiman detention camp, where he was interrogated, detained and tortured over a period of 37 days.

<sup>36</sup>

According to Asaad's testimony, the most intense phase of his interrogation occurred specifically during the first nine days of April.<sup>37</sup>

Testimony of Asaad:

*'They asked me if I saw what they did with the bodies, I said no. They told us that the ambulances had sirens, not lights. I said no - I was scared, terrified of them, scared they would kill me. They asked me if anyone was filming the scene, from*

<sup>34</sup> Testimony of Munther: "The first thing they asked me to do was begin with the women and children. Some of them were mothers carrying children who had been killed, one whose son had been shot in the chest. And another, who was also carrying her dead daughter, also shot in the chest. There was one young girl who had been shot in the right leg, and so many older people needing medical attention - whether from the women or the men. So of course, I started to get them organised into lines of men and women. They weren't stopping a single one of the women. They were telling me to bring them 10 by 10, just so that they could inspect them. As they were passing, of course, anything they wanted to check, they used me to do that. They were using me as a human tool. They weren't the ones to go up to people, they made me do it. I was made to do the inspections and tell the people to put their things down, stand up like this. I had to ask them, "what do you have with them," and tell the officer. When they were finished with the line of women and children, Then came the line of men. They told me to bring them five by five and stand them in front of their cameras. I told them to face the cameras, to take their glasses off, put their things down, or take their hats off. If there was anyone they wanted to arrest, they told me - bring him here to the left, to the pits that I told you about."

<sup>35</sup> <https://x.com/tamerqdh/status/1903793645871870124?s=20>, <https://x.com/qudsn/status/1903773352201740656?s=20>, <https://x.com/ahmedhijazee/status/1903829304435523735?s=20>, <https://x.com/qudsn/status/1903950355714408508>

<sup>36</sup> Testimony of Asaad: 'After the solitary confinement, they took me to a place that they call the Disco. It's full of noise and sound. They'd put us in there with our hands tied up, our eyes covered. Everyone had to stay on the floor, we were forbidden to get up, you had to stay seated or on your back. Even if you needed to sleep, the music would stay on, loud through the night. It was so loud you could feel your ears bleeding, it felt like my head was going to explode. If you were in there even for an hour, you couldn't cope. They would wake us up, go away, wake us up again, and always the music was playing. Then they took us to the interrogation. The interrogation room was a room like this. They came and took us, tied us up to the chair, and started the interrogation. It started in the morning until the end of the day. And then back to the Disco.'

<sup>37</sup> Testimony of Asaad: 'The first day, when they got us there, we were fasting, so they bought food for us in the middle of the night. When they took us there they put us in some barracks. The second day, they took us to the secret services - the Shabak, wearing civilian clothes. That's where they tied us up and interrogated us all day. It was always beatings. The next day was Eid, it was 1 or 2 April. They took me from where the men were and took me to the intelligence agents. I was there for 9 days, in total. Interrogation every day. It was solitary confinement in that place, in a tiny little cell. The first three days I was just in there, I couldn't see the sun or the sky, what day it was. The beds were infested and mouldy - so much so that I started getting a rash.'

*the east of the road or the west, from anywhere far away. I told them I was scared, I don't remember because I was so scared. They said to me, "did anyone film this?" and I told them no.'*

This timeframe coincides with the period in which new claims and corrections were being put forward by the Israeli military. On 3 April, the Israeli military reportedly issued a statement to Sky News claiming that they had provided the UN with the location of the site where the bodies of the executed Palestinian aid workers and their emergency vehicles were buried.<sup>38</sup> On 4 April, the video recovered from Refaat's phone was made public. As established in this report, Refaat and Asaad were in the same ambulance, which is clear from that video. That same week, Munther gave interviews to several media outlets recounting the trajectory of the attack and testifying to the identifying markings and use of internal and external lights across the emergency vehicles.<sup>39</sup> On 6 April, the Israeli military changed its initial account of the incident, with one of its spokespersons stating at a press briefing that the person who had given the initial account was 'mistaken' and that their investigation into the incident was ongoing; he also reiterated the claim that they had identified Hamas militants among those killed, and denied that any of the victims had been shot at close range.<sup>40</sup> Throughout this period, Asaad was repeatedly questioned about what he had seen and whether anyone else present at the scene might have documented the incident.

This sequence of events suggests coordinated efforts by the Israeli military to control the narrative and conceal evidence of their actions. As details emerged challenging their account of the events of 23 March 2025, officials continued to publicly revise their narrative – insofar as was necessary with each new revelation – while continuing their torture and interrogation of Asaad.

#### 5.4 Locating the Sites of Execution and Burial of the Aid Workers

Between 27 and 30 March, fifteen bodies were recovered from the incident site: eight PRCS crew members, six PCD crew members, and one UNRWA worker. Satellite imagery and video recordings together confirm the location of a mass grave in this site (Figure 40, Figure 41, Figure 43, Figure 44). The remains of two UN vehicles were recorded during the exhumation on 30 March (Figure 42).



Figure 40: Left: Still from the exhumation on 30 March 2025, showing the mass grave in the foreground. Right: Matched view of the still within the 3D model.

<sup>38</sup><https://news.sky.com/story/gaza-ambulance-crushed-by-idf-as-aid-attacks-increase-13340782>

<sup>39</sup> <https://www.bbc.co.uk/news/articles/ckgere1y740o>, <https://www.theguardian.com/world/2025/apr/03/i-heard-them-take-their-last-breath-survivor-recounts-gaza-paramedic-killings>, <https://www.reuters.com/world/middle-east/palestinian-paramedic-says-he-saw-israeli-troops-firing-emergency-vehicles-2025-04-05/>,

<sup>40</sup> <https://www.reuters.com/world/middle-east/israeli-military-changes-initial-account-gaza-aid-worker-killings-2025-04-06/>



Figure 41: Still from the model showing the location of the mass grave in relation to the electricity pole, the tall structures and the interrogation pit.

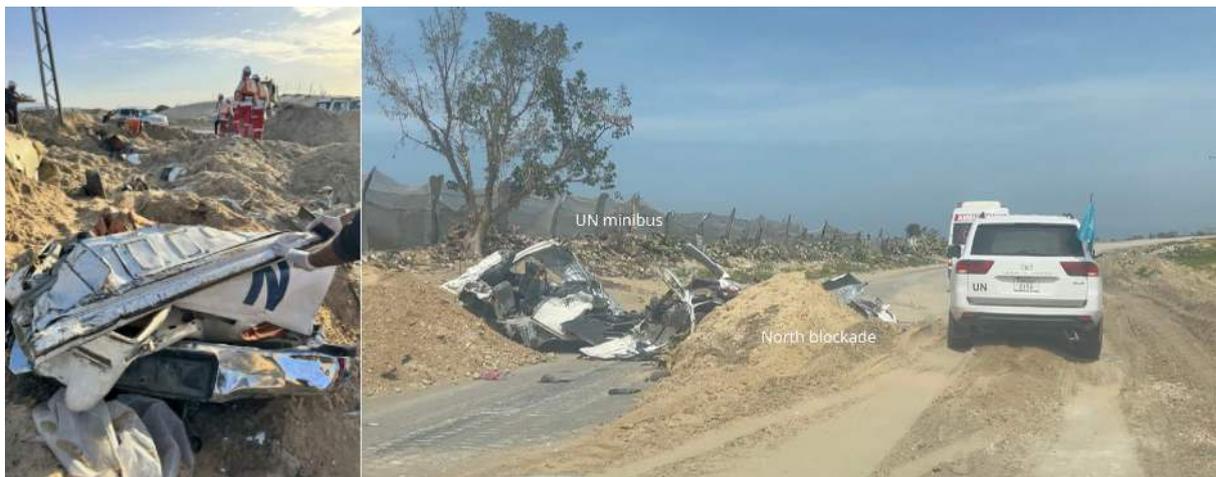


Figure 42: Left: still from the exhumation on 30 March 2025, showing the remains of the UN Toyota. Right: Annotated still from the exhumation on 30 March 2025, showing the remains of the UN minibus. Source: OCHA.

Our investigation identified the locations at which the following victims were killed:

Mustafa Khafaja, ambulance officer, PRCS  
Ezz El-Din Shaat, ambulance officer, PRCS  
Salah Muammar, ambulance officer, PRCS  
Ashraf Abu Libda, first responder volunteer, PRCS  
Refaat Radwan, first responder volunteer, PRCS  
Muhammad al-Hila, first responder volunteer, PRCS  
Muhammad Bahloul, first responder volunteer, PRCS

Zuhair Abdul Hamid al-Farra, fire truck driver, PCD  
Fouad Ibrahim al-Jamal, ambulance driver, PCS

Kamal Mohammed Shahtout, UNRWA

By transferring the victims' bodies to a mass grave, as well as destroying their vehicles, Israeli military personnel appear to have attempted to conceal and disturb evidence of the attack.



Figure 43: Annotated satellite image from 26 March 2025 showing the location of the mass grave in relation to the earth berms, the electricity pole, the tall structures and the interogation pit. (Source: Planet Labs PBC)



Figure 44: Annotated satellite image from 26 March 2025 showing the location of the bodies of aid workers and their vehicles before the burial and concealing. (Source: Planet Labs PBC)

## 5.5 Construction of a GHF distribution site over the site of the massacre

The earthworks that began in the hours after the attack led eventually to the construction of a GHF distribution site. The GHF aid distribution system began in Gaza in late May 2025, two months after the 23 March incident.<sup>41</sup> Satellite imagery from the months following the attack captures the development of the GHF site (Figure 45, Figure 46, Figure 47, Figure 48, Figure 49).

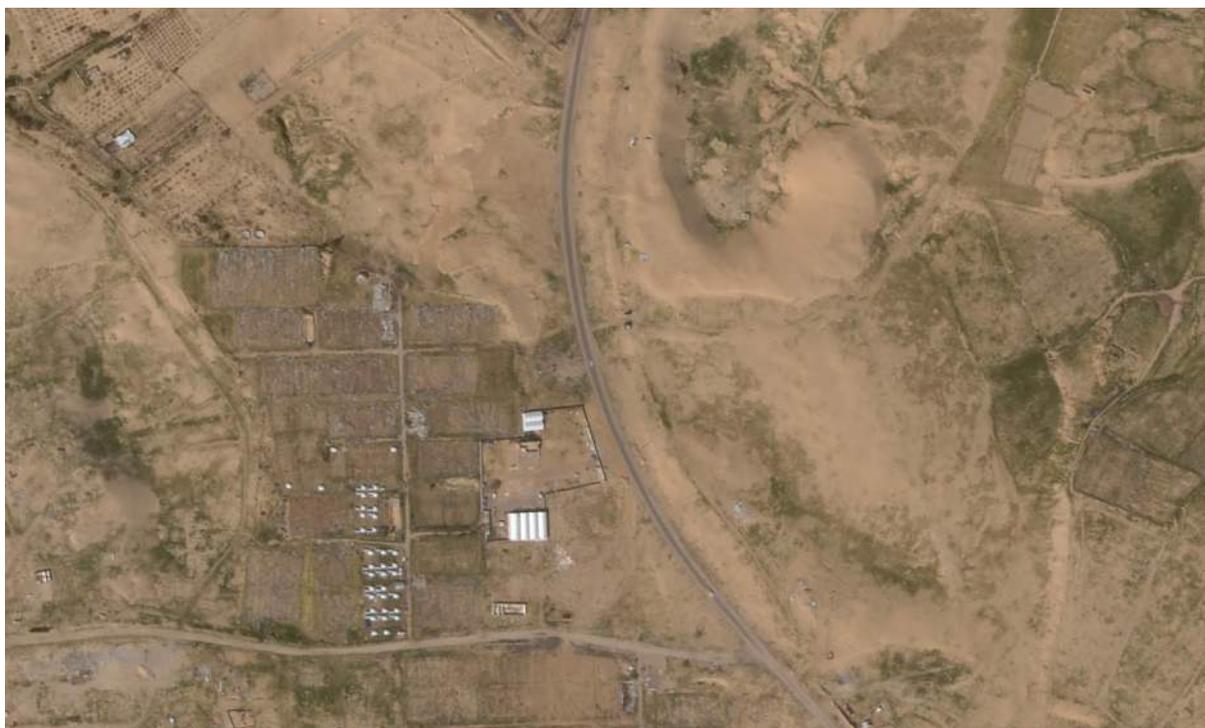


Figure 45: The site of the on 16 March 2025, five days prior to the incident. (Source: Planet Labs PBC)

<sup>41</sup> FA's research has established that GHF sites are run by the Israeli military, and operates outside of existing social structures and community mechanisms. The distribution of aid is limited in quantity and inadequate in provision. For example, the GHF sites provide a mostly dry 'ration', consisting of food but not including water, medical supplies or other forms of aid. People receive little or no notice about the provision of aid. Our findings show that, between 19 June and 4 July, the GHF ration stations were open for an average of 10 minutes at a time. Airdropped aid typically falls at random times in unspecified locations. There is no audit of provisions after they are distributed, or follow-up to assess the impact of the programmes. For more information see <https://forensic-architecture.org/investigation/aid-in-gaza>



Figure 46: The site on 26 March 2025, three days after incident. Yellow annotations mark the construction of earth berms, and tracks from heavy military vehicles. (Source: Planet Labs PBC)



Figure 47: The site under construction on 30 May 2025, 68 days after the incident. The Israeli constructions for the evacuation route (marked in yellow) largely overlap with those for the GHF rotation site (in red). (Source: Planet Labs PBC)



Figure 48: The site when the GHF rotation site is active on 12 September 2025, 173 days after the incident. Source: Planet Labs PBC



Figure 49: Left: The barricade set up for the evacuation route on 23 Mar 2025 perfectly overlaps with the barricade set up for the collection of aid on 12 Sep 2025 (right). Right: The routes set up for the evacuation route on 23 Mar 2025 (left) perfectly overlaps with the road set up for the delivery of aid on 12 Sep 2025 (right). (Source: Planet Labs PBC and Airbus Defence and Space)

## 6. ABOUT FORENSIC ARCHITECTURE

Forensic Architecture (FA) is a research agency, based at Goldsmiths, University of London. The team includes architects, academics, journalists, and other specialised professionals and experts. We have provided spatial research and evidence for numerous human rights investigations and prosecutions under international law, including at the UN General Assembly in New York in October 2013, and the Human Rights Council in Geneva in 2014 (on drone warfare via the UNSRCT).

### 6.1. *Selected Submissions to Legal Processes and Parliamentary Inquiries*

Our report on the Use of White Phosphorus in urban environments was presented in 2011 in the Israeli High Court, and at the UN Human Rights Council (HRC) in 2012.

We presented findings to the French Tribunal de Grande Instance in 2012 (1317601476; 2300/13/69). In 2019, the same work was cited in a communication to UN HRC in *SDG vs. Italy*.

We presented findings to the UN General Assembly alongside the UN Special Rapporteur on Counter-Terrorism and Human Rights (Ben Emmerson KC) in October 2013 and the UN HRC in 2014 (FA's reports: 1 / 2 / 3 / 4).

We submitted findings to the Inter-American Court of Human Rights in 2013 on the case of the genocide perpetrated against the Ixil Maya. In March 2024, Professor Weizman was cross-examined in the criminal trial of Lucas Garcia in the First Criminal Sentencing Court for High Risk Processes Group A, brought by the Human Rights Office of the Archbishop of Guatemala (ODHAG).

We presented in the Israeli High Court in the case of *The Committee of the Village of Battir vs. the Ministry of Defence* (HCJ 7612/12).

Our findings on the 2014 bombing of Rafah by Israel were submitted to the International Criminal Court (ICC) and the UN Independent Commission of Inquiry in 2015.

Our investigation of the murder of Pavlos Fyssas was played in the Court of Appeal of Athens in 2018, as part of the trial of 69 members of the Golden Dawn political organisation (2425, 2644/22-10-20).

Our 2018 findings on the killing of Tahir Elçi were cited by UN rapporteurs as instrumental in the re-opening of the state's investigation and were cited in the prosecutors' indictment in 2020.

Our investigation into the presence of Russian military units in eastern Ukraine in 2014 was submitted to the European Court of Human Rights (ECtHR) by the European Human Rights Advocacy Centre (EHRAC) in 2019.

Our investigation into the pushbacks of Turkish nationals Ayse Erdogan and Kuzey in the Evros/Meriç in May 2019 was submitted to the ECtHR by the Greek Council for Refugees (*A.R.E. v. Greece*, 15783/21, and *Akçay and Others v. Greece*, 60702/21).

Our investigation into the enforced disappearance of a Syrian man in the Evros/Meriç in November 2016 was submitted to the United Nations Human Rights Committee in 2020 by the Global Legal Action Network (GLAN).

Our investigation into the killing of Muhammad al-Arab at the Greek-Turkish border of Evros/Meriç was submitted by lawyers from Turkey's Edirne Bar Association to the ECtHR.

Our investigation into the killing of Muhammad Gulzar at the Greek-Turkish border of Evros/Meriç was submitted to the ECtHR. Gulzar's family also initiated legal proceedings in Greece (Muhammad v. Greece, App No 34331/22), during which FA staff testified pre-trial as expert witnesses. These investigations led to an emergency hearing of the LIBE Committee of the European Parliament in July 2020 during which our reports were extensively discussed.

Our investigation into the pushbacks of Parvin A. was submitted to the United Nations Human Rights Committee in February 2022 by the European Centre for Constitutional and Human Rights (ECCHR).

Our investigation into intentional fire-setting in Papuan rainforests was submitted to a court in Hamburg in February 2021 (324 O 561/19).

Our investigation into the 2011 police killing of Mark Duggan in London, commissioned by lawyers for the Duggan family, was submitted to pre-trial negotiation in the case of Pamela Duggan & Others v The Commissioner of Police for the Metropolis, Claims No. HQ12X02226 and HQ12X02909.

Following our investigations into the right-wing terror ambush in Hanau, Germany, in February 2020, FA was invited to present as expert witnesses at the investigative inquiry UNA 20/2 of the Hessen state parliament.

FA's research was commissioned by the Colombian Truth Commission towards its final report, published in 2023. Following the submission to the Colombian Truth Commission, Forensic Architecture was commissioned as an independent expert by the Comite de Solidaridad con Presos Politicos to analyse the materials of the criminal case 1110016000013201913891 into the death of Dilan Cruz.

Our investigation into the killing of LGBTQ+ activist Zak Kostopoulos was submitted to court in Athens in 2021, and FA's lead investigator for the case, Christina Varvia, testified as an expert witness in January 2022 and in January 2024, at the first and second degree trials respectively.

Our investigation into drift-backs of asylum seekers in the Aegean Sea has been submitted to the European Court of Human Rights as supporting evidence for two cases filed by victims against Greece (e.g. G.R.J. v Greece (app.no. 15067/21) and A.A.J. and H.J. v Greece (app.no.24982/21)). The investigation's findings were reviewed and deemed credible by FRONTEX, the European Border and Coast Guard Agency, at the request of MEP Erik Marquardt.

Our director, Professor Eyal Weizman, appeared as an expert witness in R v. Gwynne & Bin Hishamundin at Loughborough Magistrates Court in 2023.

Our investigation into the September 2020 fire in Moria refugee camp was submitted to the Mixed Jury Appeal court of the North Eastern Aegean in Greece in the appeals against decisions 46-55/2021 (ABM A-2020/2076) in March 2024.

FA's expert report and reconstruction of a train collision was submitted to Circuit Court of Cook County, Illinois, USA (Case No: 2002 L 005325) in September 2024.

FA's expert report and reconstruction of the police killing of Sean Fitzgerald by the West Midlands Police in Coventry, UK was submitted the Coventry and Warwickshire Coroners Court in February 2025. FA's lead investigator on the case, Kishan San, testified as an expert witness at the Coroners Court in May 2025.

## **7. ABOUT EARSHOT**

Earshot is the world's first non-profit organisation using sound in the defense of human and environmental rights. Building on over a decade of research and advocacy, Earshot transforms sound into a tool of justice and restores the soundtrack as a site of evidentiary power. From the sharp crack of gunfire to the oppressive hum of drones, our investigations treat sound as both an acoustic trace of violence and a means of control.

In under three years, Earshot's investigations have provided facts for over 30 major media outlets, including Al Jazeera, the BBC, the Washington Post, the Guardian, Middle East Eye, Sky News and Le Monde, and have supported advocacy campaigns by Amnesty International, Human Rights Watch, B'Tselem, Forbidden Stories, and Global Rights Compliance.

Through original research and investigative cases — often collaborating with journalists and human rights organisations — Earshot demonstrates how sound can expose abuse, shift public perception, and amplify voices too often unheard. By embedding itself in a wider ecosystem of media outlets, legal teams, activist networks, and human rights organisations, Earshot produces expert audio evidence no other organisation is equipped to deliver — strengthening calls for accountability in courtrooms, public forums, and international advocacy campaigns.

## 8. APPENDIX: AUDIO INVESTIGATION IN DEPTH

### A.1 Refaat Radwan's video

#### [A.1.1 Audio ballistic analysis: 93% of shots fired towards the aid workers](#)

An audio ballistic analysis of the 844 gunshots captured in Refaat's video established that Refaat's camera was consistently in the line of fire throughout the period of audible gunshots.

Audio ballistic analysis looks at the constituent sounds that make up the sound of a gunshot. These constituent sounds contain crucial spatial information, such as the trajectory of the gunfire in relation to a recording device, and the distance between the shooter and the recording device. To extract this information, the type of weaponry must first be known.

Munther Abed testified being held at gunpoint by Israeli soldiers, with *'an M16 assault rifle pointed on my back'*, and witnessing *'all the soldiers around me shooting', 'directly at the convoy.'* The M16 rifle fires most commonly 5.56x45mm calibre bullets, which travel at supersonic speeds of 900 to 950 metres-per-second.<sup>42</sup>

When a recording device is in the line of fire of weaponry that fires supersonic ammunition, such as the 5.56x45mm calibre M16 assault rifle, two sounds are typically audible. First, the sound created by the bullet flying past the camera at supersonic speeds, creating a supersonic shockwave as it moves through the air. Second, the sound of the combustion created by the hot gases expanding from the cooler ambient air as they are discharged from the muzzle of the weapon. This muzzle blast travels to the recording device at the slower speed of sound.

Earshot identified the sound of a supersonic bullet shockwave followed by the sound of the muzzle blast in 789 out of the 844 gunshots, indicating at least 93% of gunfire was fired towards Refaat's camera and the emergency vehicles' positions.

#### [A.1.2 Multiple shooters firing simultaneously](#)

The density of gunfire in Refaat's video frequently exceeds 900 rounds-per-minute (RPM), the highest rate of fire for a single M16 rifle.<sup>43</sup> In automatic mode, 900 RPM translates to one bullet fired every 67 milliseconds. At minute 01:25.457, 5 gunshots are audible during the shortest possible time that it takes an M16 to fire one bullet, reload and shoot again (Figure A1). This, in addition to the irregular intervals between each of these 5 shots, indicates that there were at least 5 shooters firing simultaneously.

Earshot's audio analysis can confirm at least 5 shooters were firing towards the emergency vehicles and aid workers in this instance alone. Earshot does not exclude the possibility that additional shooters were present, firing the remaining 841 gunshots heard in Refaat's video. Both Asaad and Munther

<sup>42</sup> <https://archive.org/details/operators-manual-for-rifle-5.56-mm/page/n15/mode/2up> (Accessed November 3, 2025)

<sup>43</sup> <https://archive.org/details/operators-manual-for-rifle-5.56-mm/page/n15/mode/2up> (Accessed November 3, 2025)

testified that the number was much higher, with Asaad saying there were ‘*at least 12 soldiers,*’ and Munther saying there were ‘*at least 30.*’

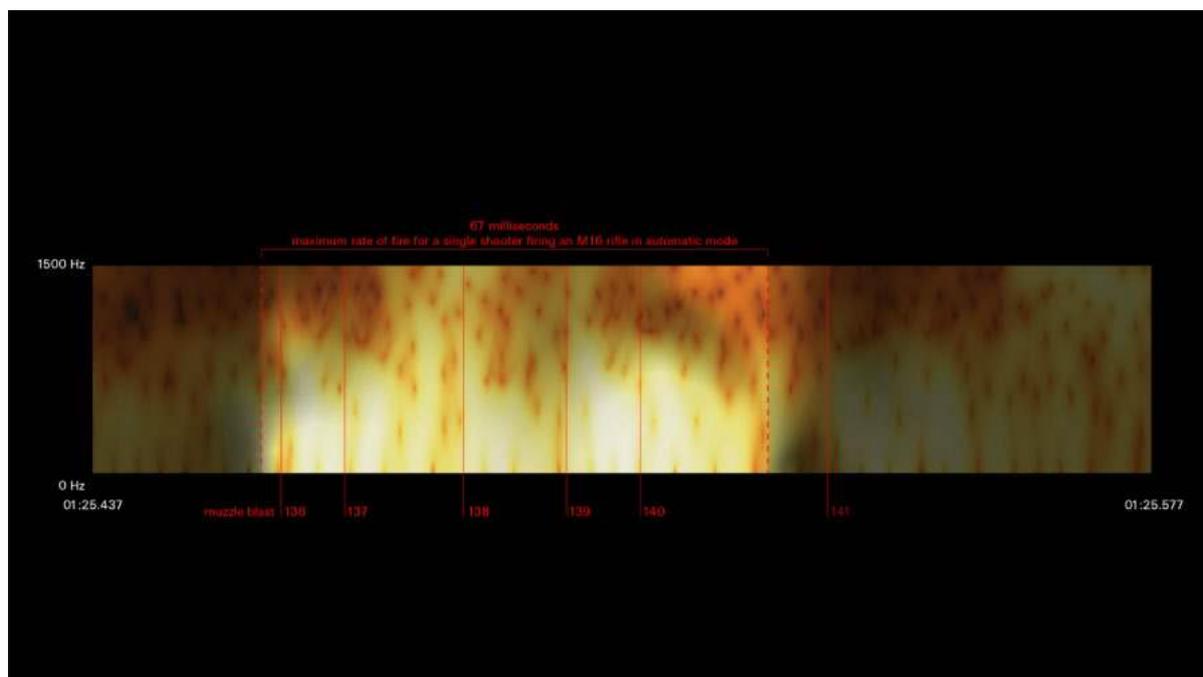


Figure A1: Annotated spectrograph showing instance of 5 gunshots fired within 67 milliseconds, the time equivalent to the maximum rate of fire of a single M16 rifle, indicating at least 5 shooters present.

## A.2 Timeline of the attack

### A.2.1 5:09 am – 5:13 am: Fixed firing position on elevated sandbank

#### [A.2.1.1 Audio ballistic analysis: estimating shooter distance](#)

As mentioned in paragraph A.1.1, the supersonic bullet shockwave and the muzzle blast, contain information pertaining to the trajectory of gunfire. Additionally, the interval in time between these two sounds can be used to estimate the distance between the shooter and the recording device.

To calculate this distance, the following variables must be known: the bullet’s point of impact, the interval in time between the sound of the bullet’s supersonic shockwave and the muzzle blast, the bullet’s velocity, and the speed of sound at the time of day.

Earshot identified several gunshots whose point of impact was known. Asaad, who arrived in the same ambulance as Refaat, testified that the first gunshots fired at the convoy were ‘*hitting my ambulance first.*’

The interval in time (t) between the supersonic bullet shockwave and muzzle blast for the first three gunshots is between 73 and 77 milliseconds (Figure A2).

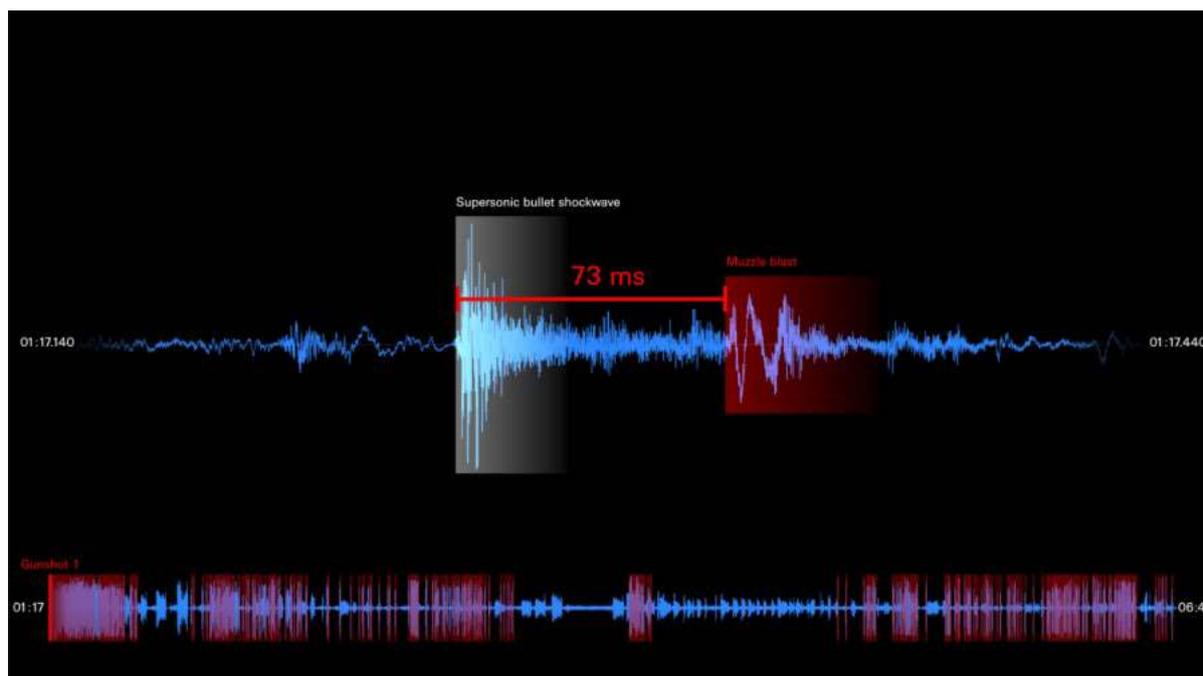


Figure A2: Supersonic bullet shockwave and muzzle blast identified in the first gunshot from Refaat’s recording, which Asaad describes making impact on his and Refaat’s ambulance.

The bullet velocity ( $v$ ) could be estimated through Munther’s testimony on the use of M16 rifles by the surrounding Israeli soldiers. The M16 rifle fires bullets between 900 to 950 m/s.<sup>44</sup>

The speed of sound ( $c$ ) was approximately 336 m/s, based on the temperature of 8 degrees Celsius at the time of the attack.<sup>45 46</sup>

The variables needed to calculate the distance of the shooter to Refaat’s position are:

- Time interval between shockwave and muzzle blast ( $t$ ) = 73 to 77 milliseconds
- Bullet velocity ( $v$ ) = 925 metres per second  $\pm$  25 m/s
- Speed of sound ( $c$ ) = 336 m/s

The distance ( $d$ ) of the shooter to Refaat’s position is derived through the following equation:

$$d = (v \cdot c \cdot t) / (v - c)$$

$$d = (925 \cdot 336 \cdot 0.075) / (925 - 336)$$

$$d \approx 39.6\text{m} \pm 1.6\text{m}$$

<sup>44</sup> <https://archive.org/details/operators-manual-for-rifle-5.56-mm/page/n15/mode/2up> (Accessed November 3, 2025)

<sup>45</sup> <https://www.wunderground.com/history/daily/il/LLBG/date/2025-3-23> (Accessed April, 2025)

<sup>46</sup> <https://www.omnicalculator.com/physics/speed-of-sound> (Accessed November 3, 2025)

Earshot therefore estimated the shooters were positioned between approximately 38 to 41 metres from Refaat and Asaad’s ambulance at the start of the shooting, as highlighted by the red area in figure A3.

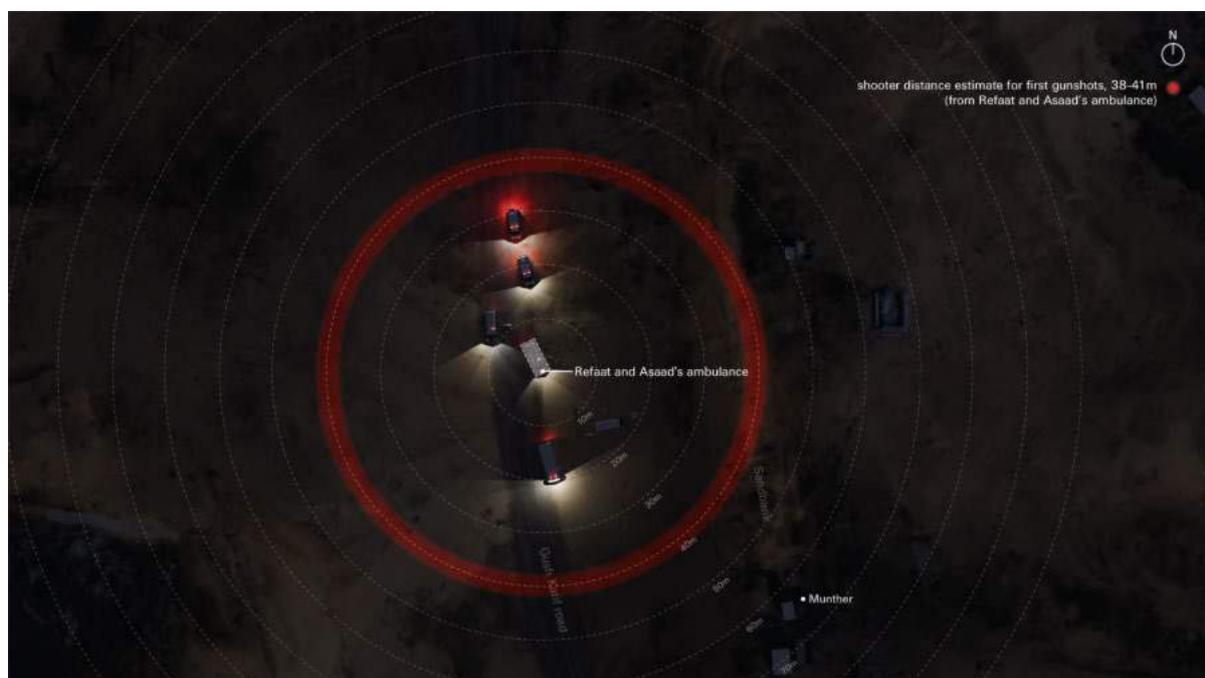


Figure A3: Estimate of shooter positions for the first gunshots heard in Refaat video, which Asaad describes making impact on his and Refaat’s ambulance.

At minute 03:23.019, 2 minutes and 5 seconds into the gunfire, Earshot identified a second instance where a gunshot makes impact in proximity to Refaat.

This gunshot, number 547, contains a distinct supersonic bullet shockwave that suggests the bullet is making impact on an ambulance close to Refaat’s position. This is established by looking at the shockwave’s time of decay, as well as by looking at its pronounced mid-high frequency content.

Most of the 786 shockwaves in Refaat’s video appear as extremely short impulses, lasting only 5 to 10 milliseconds, with little to no audible or observable decay. These short impulses are the sound of the bullet ‘whipping’ through the air, causing a sound like the crack of a whip.

The supersonic bullet shockwave for gunshot 547, however, is different. This gunshot has a longer decay that lasts over 180 milliseconds. Rather than a quick impulse of sound, this protracted decay points to an object resonating to the energy of something making impact onto it. This resonance is observable through the presence of much more pronounced mid-high frequency content, between 2 to 20 kHz, compared to a typical supersonic bullet shockwave (Figure A4). In more general parlance, one would refer this resonance as having a metallic like sound or ring to it.

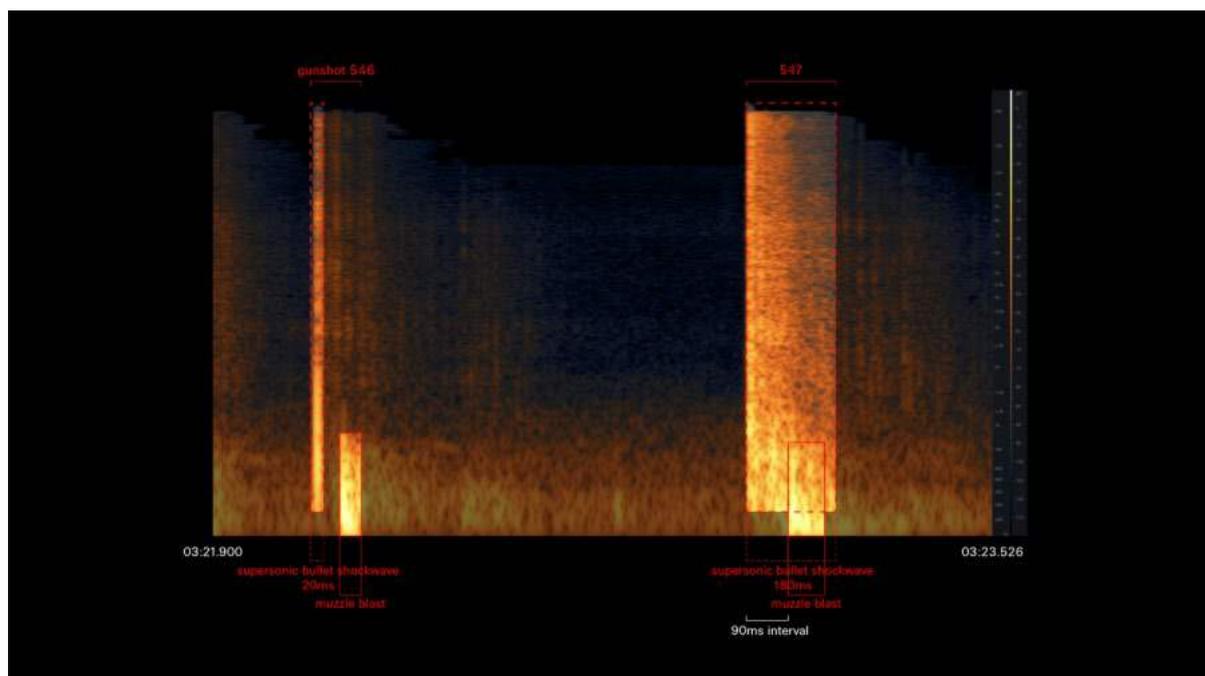


Figure A4: Spectrograph of gunshot 546 showing the supersonic shockwave of the bullet likely flying past the camera, and gunshot 547, showing the sound of the bullet likely making impact on an ambulance, extremely close to Refaat’s camera.

Having established this gunshot is making impact on a vehicle extremely close to Refaat, the distance between the shooter of this gunshot and Refaat can be estimated.

The interval between supersonic bullet shockwave and muzzle blast for gunshot 547 is 90 milliseconds.

Using the same calculations for the first gunshots, Earshot could place the shooter for gunshot 547 between approximately 47 and 48 metres from Refaat’s position, as highlighted by the orange area in figure A5.

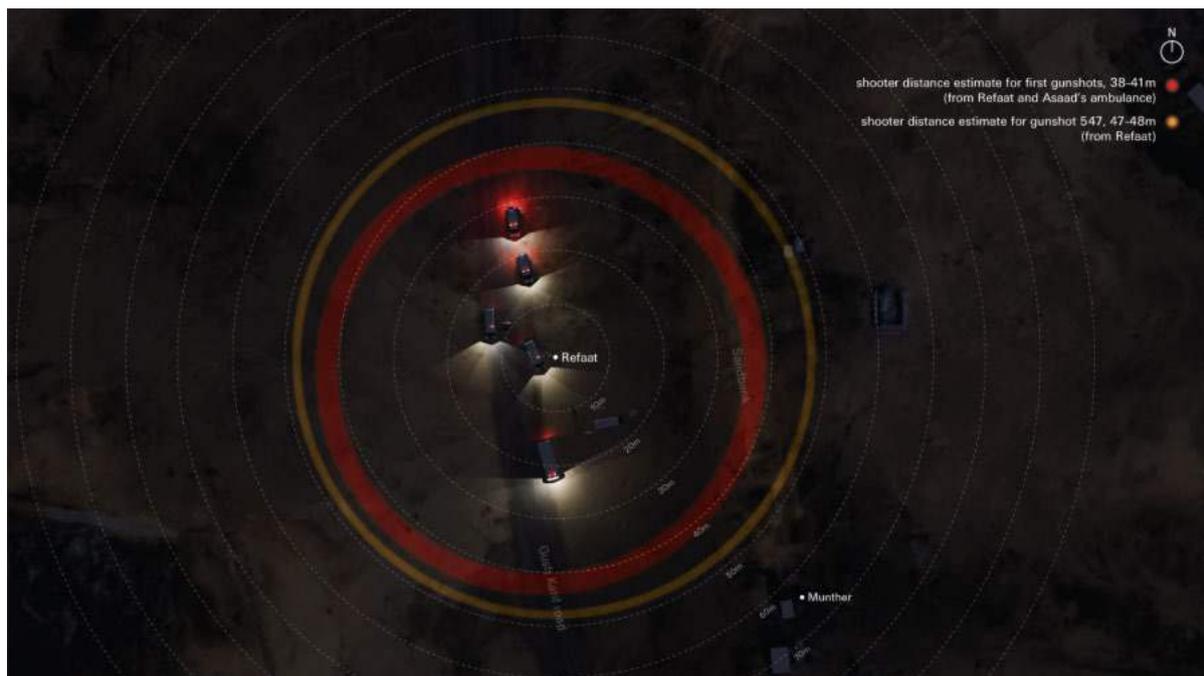


Figure A5: Shooter distance estimates derived from simulating gunshot 547 making impact with the closest ambulance to Refaat’s position.

Using descriptions from Asaad’s testimony Earshot could narrow down these shooter positions even further. Asaad states: *‘We expected that the shooting was coming from the west at first. This is why everyone got out to the east, even Mustafa [Khafaja] and Izz [Ezz El-Din Shaat]. But it was actually coming from behind them.’* (Figure A8). This would indicate the gunfire was coming from an easterly origin relative to the position of the aid workers.

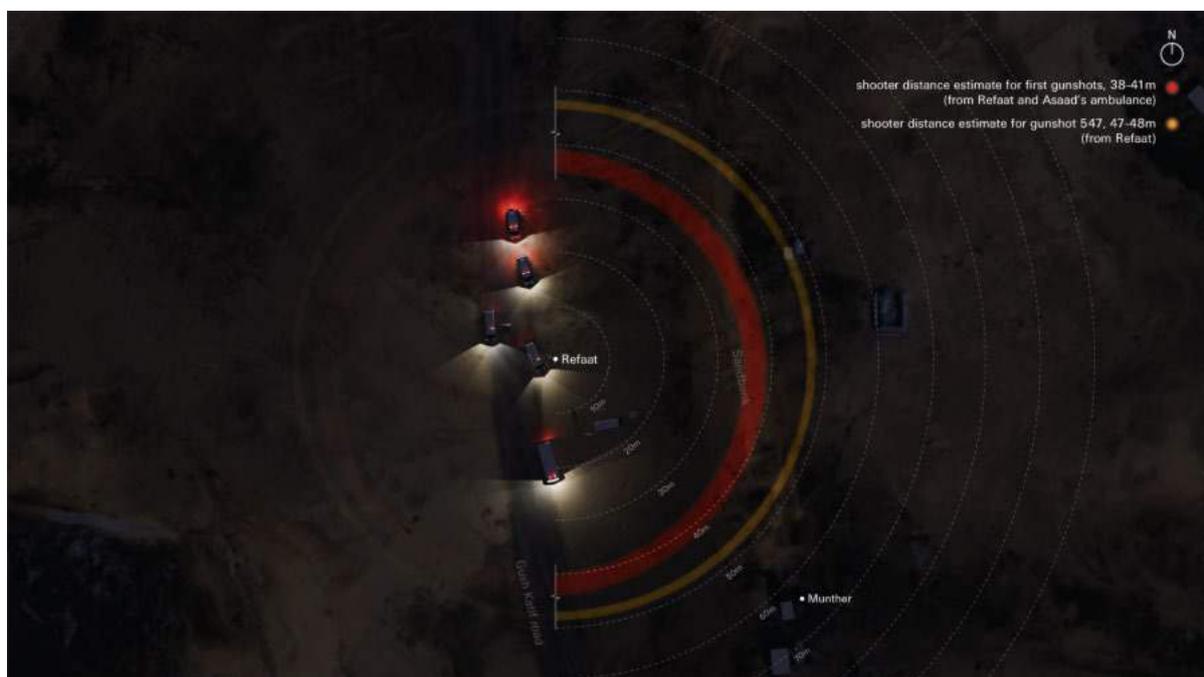


Figure A6: Refined shooter distance estimate based on eastward gunshot origin as identified by Asaad.

### A.2.1.2 Echolocation: confirming shooter position

Earshot supplemented the audio ballistic analysis from paragraph A.2.1.1 through a process of echolocation to arrive at an even more precise estimate of the shooters' positions.

Echolocation is the process of locating the source of a sound based on an analysis of the sound's echoes and the environment in which the sound travels.

In the first 4 minutes of gunfire of Refaat's video, between 5:09 am and 5:13 am, at least 50 gunshots contained a clearly distinguishable muzzle blast echo, heard between 558 to 603 milliseconds after the sound of the muzzle blast (Figure A7).

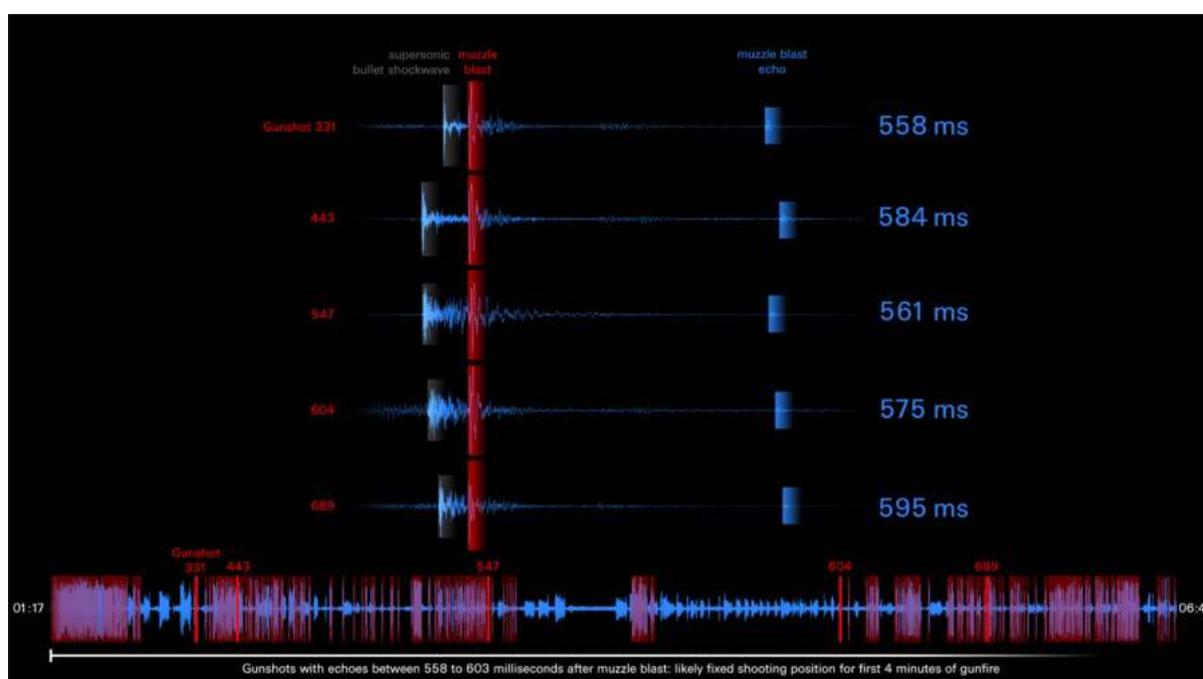


Figure A7: gunshots with audible muzzle blast echoes 558 to 603 milliseconds after the muzzle blasts in the first 4 minutes of gunfire of Refaat's video.

These echoes are the sound of the muzzle blast reflecting off a nearby surface and travelling back to Refaat's camera. Given massive amounts of destruction and clearance of and around the area of the attack, very few surfaces from which a sound could reflect were left standing. Earshot could identify a flat, 2-metre tall, 50-metre-wide concrete wall, facing Refaat's position, 130 metres south (Figure A8). This is the only surface capable of producing such clear and defined echoes of over 558 milliseconds for sounds originating along the red and orange areas shown in figure A6 in paragraph A.2.1.1.



Figure A8: 3D visualisation of remaining surfaces (blue) on the site, and the 2-metre concrete wall most likely causing the muzzle blast echoes heard on Refaat's video.

Earshot simulated the propagation of a muzzle blast originating from the red and orange areas shown in figure A6, travelling at 336 m/s, reflecting off the 2-metre concrete wall and travelling back to Refaat's position. The simulation allowed Earshot to precisely locate the positions from which a gunshot would produce echoes of 558 to 603 milliseconds, as heard from Refaat's position. Through this simulation, Earshot could narrow down the shooting position to the area highlighted in white in figure A9, between 38 to 48 metres southeast of Refaat.

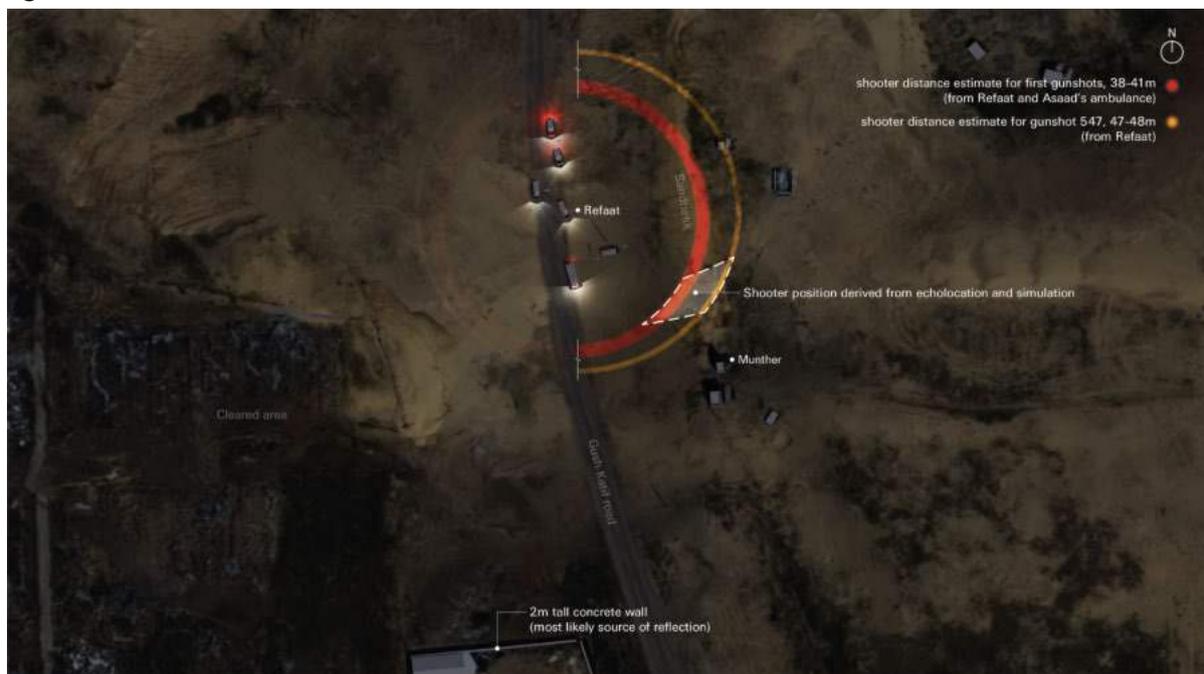


Figure A9: White-dashed outline likely position of the Israeli soldiers for the first 4 minutes of Refaat's video, derived from an analysis of muzzle blast echoes and from the interval between supersonic bullet shockwaves and muzzle blasts.

### A.2.1.3 Stationary shooting position for first 4 minutes of gunfire

The echoes following the muzzle blast identified in paragraph A.2.1.2 remain stable, between 558 to 603 milliseconds, across more than 50 gunshots in the first 4 minutes of gunfire.

The interval in time between a sound and its echo is highly dependent on the relationship in space between the sound emitter, the surface causing the echo, and the recording device. Changes in the position of either of these three variables result in the sound travelling along new paths, to a reflective surface and back to a recording device. These changing conditions cause the echo to arrive earlier or later at the recording device.

The stable interval between 558 to 603 milliseconds most likely indicates that the Israeli soldiers were firing from the same fixed position, identified in figure A9 in paragraph A.2.1.2, for the first 4 minutes of gunfire.

### A.2.1.4 Corroborating detail: Vehicle movement during the attack

During the gunfire, Asaad, who was crawling through the emergency vehicles seeking cover, described witnessing one of the emergency vehicles attempting to escape: *'[the driver] was trying to get away from the place. I remember where the car was, and where it stopped in the sand. The driver was killed, but his foot was still on the gas and the wheels were moving in the sand.'*

At minute 02:01.000 in Refaat's video, Earshot identified the sound of a vehicle engine, revving as the vehicle accelerates. This sound lasts for 8 seconds before it becomes inaudible beneath a renewed volley of heavy gunfire (Figure A10).

Earshot's audio analysis provides a small but crucial corroborating detail that places Asaad's testimony in time. This corroboration increases the resolution of the reconstruction of the attack and provides further substantiation between Asaad's account and the audio evidence preserved in Refaat's video.

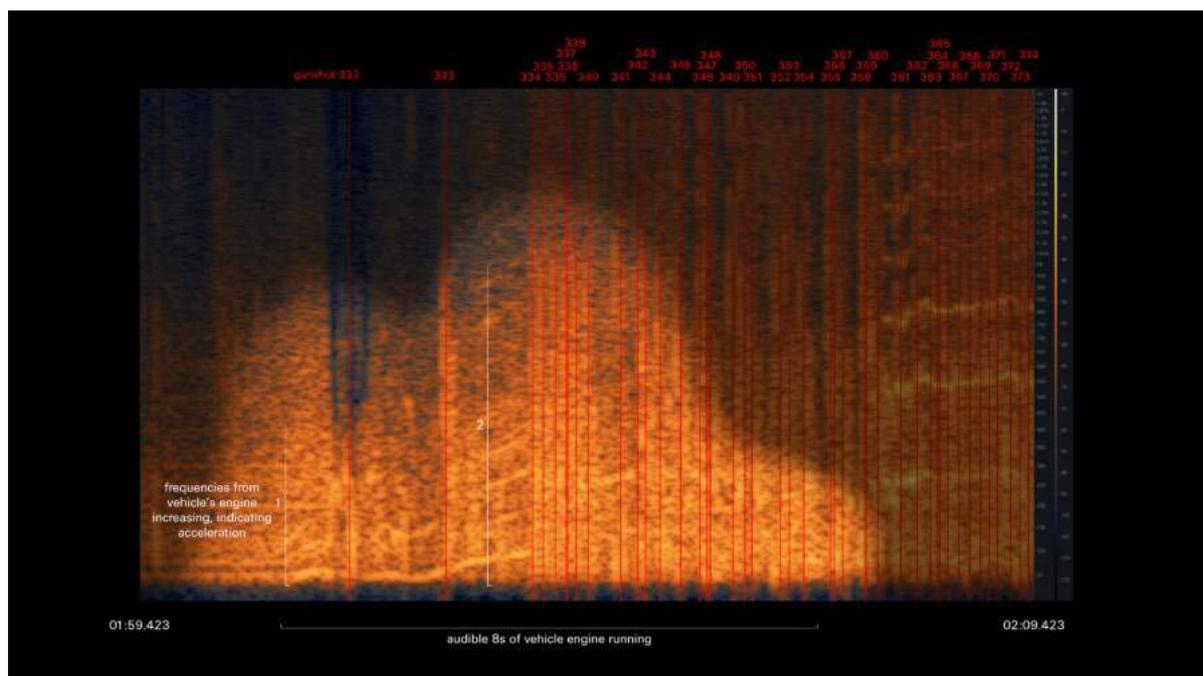


Figure A10: Spectrograph of vehicle movement audible in Refaat’s video, 44 seconds after the first gunshot.

## A.2.2 5:13 am: Coordinated advance while firing

### [A.2.2.1 Echolocation: Increasing interval between muzzle blast and muzzle blast echo](#)

Asaad describes the moment when he sees the Israeli soldiers advancing towards the emergency vehicles and aid workers: *‘when they thought they had finished us all off, they came down. It was at this exact moment that I saw them. The sun had nearly risen. It was about 12 soldiers, but there were loads more in the whole area. They were walking between [the aid workers] and shooting, coming down the hill.’*

Earshot could confirm the movement of the Israeli soldiers from the elevated sandbank towards the vehicles and aid workers as witnessed by Asaad. Earshot reached this conclusion through an analysis of the muzzle blast echoes.

In the first 4 minutes of gunfire in Refaat’s video, the echoes are heard consistently between 558 and 603 milliseconds after the muzzle blasts (Figure A7, para. A.2.1.1). After 4 minutes, the interval between muzzle blast and echo increases gradually up to 779 milliseconds in the final gunshots in Refaat’s video (Figure A11).

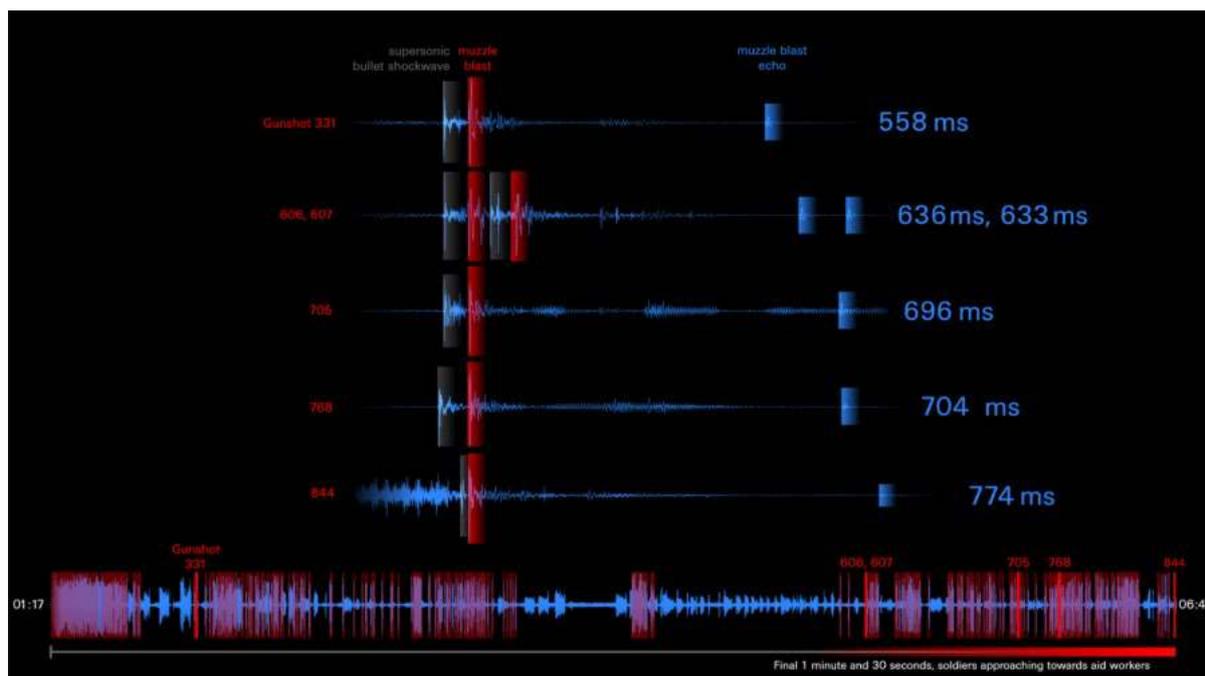


Figure A11: Increasing interval between muzzle blasts and muzzle blast echoes in the final 1 minute and 30 seconds of gunfire in Refaat’s video.

This increasing echo interval corresponds to a changing shooting position. An increasing interval between muzzle blast and muzzle blast echo indicates that the distance travelled by the muzzle blast to the 2-metre concrete wall (identified in paragraph A.2.1.2) is increasing. This translates to the shooters moving closer to Refaat’s position, and further away from the concrete wall.

In the final 1 minute and 30 seconds, this interval increases by 221 milliseconds, from 558 to 779 milliseconds. Through the same process of simulating a muzzle blast echo outlined in paragraph A.2.1.2, Earshot could reconstruct the movement of the shooters based on the increasing echo interval. The 221-millisecond increase corresponds with a shooting position that has moved over 50 metres from the initial shooting position on elevated sandbank, towards Refaat’s position, and away from the 2-metre concrete wall. By the end of Refaat’s video, this movement of approximately 50 metres places the shooters among the emergency vehicles and aid workers, within a few metres of Refaat’s position (Figure A12).

This movement of approximately 50 metres over 1 minute and 30 seconds, allows Earshot to estimate that the Israeli soldiers moved at a rate of approximately 1 metre-per-second, while continuously shooting.

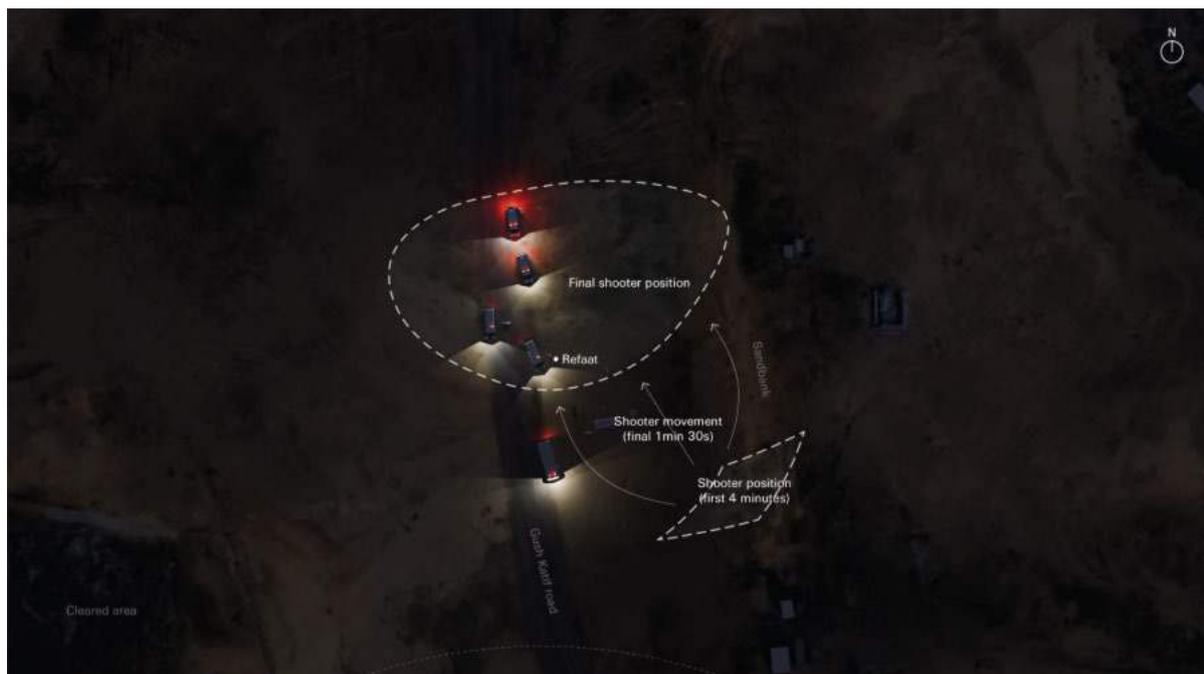


Figure A12: Map illustrating likely shooter movements and final position based on a simulation of muzzle blast echoes between 774 to 779 milliseconds, identified in the final 5 gunshots in Refaat's video.

#### [A.2.2.2 Audio ballistic analysis: decreasing interval between supersonic bullet shockwave and muzzle blast](#)

A second line of audio analysis supports the conclusion derived from the echolocation of the Israeli soldier's movement towards the vehicles and aid workers. Together with a gradually increasing echo, Earshot identified a change in the interval between the supersonic bullet shockwave and the muzzle blast in the final 1 minute and 30 seconds of Refaat's video.

The final 1 minute and 30 seconds captures at least 235 gunshots. The interval between the supersonic bullet shockwave and the muzzle blast for these gunshots gradually decreases from an initial range of 46 to 78 milliseconds to a final range between 0 to 17 milliseconds (Figure A13, highlight A).

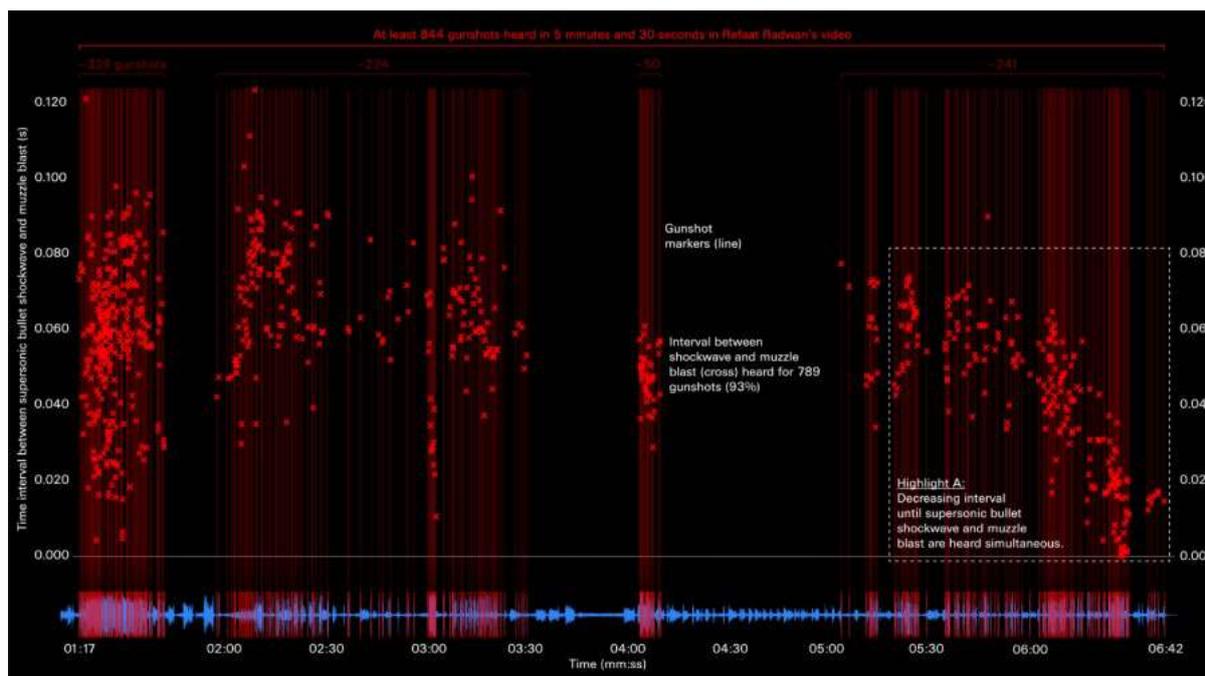


Figure A13: Timeline of 5 minutes and 30 seconds of gunfire and graph of the interval in time between supersonic bullet shockwave and muzzle blast (red 'x' markers), identified in 93% of gunshots. Highlight A illustrating decreasing interval in the final 1 minute and 30 seconds, indicating soldier movement towards aid workers.

This decreasing interval is an indication that the Israeli soldiers are moving towards Refaat's camera while continuously firing. If a shooter firing towards a recording device is far away, the supersonic bullet has more time to travel and reach the camera ahead of the slower muzzle blast. As the shooter approaches a recording device while continuously firing, these two sounds compress together in space, and arrive to the recording device in shorter intervals in time. When a shooter fires at a recording device from extremely close range, the bullet and the muzzle blast arrive at the recording device almost at the same time.

Earshot identified several gunshots where the supersonic bullet shockwave is observable at approximately the same time as the muzzle blast (Figure A14).

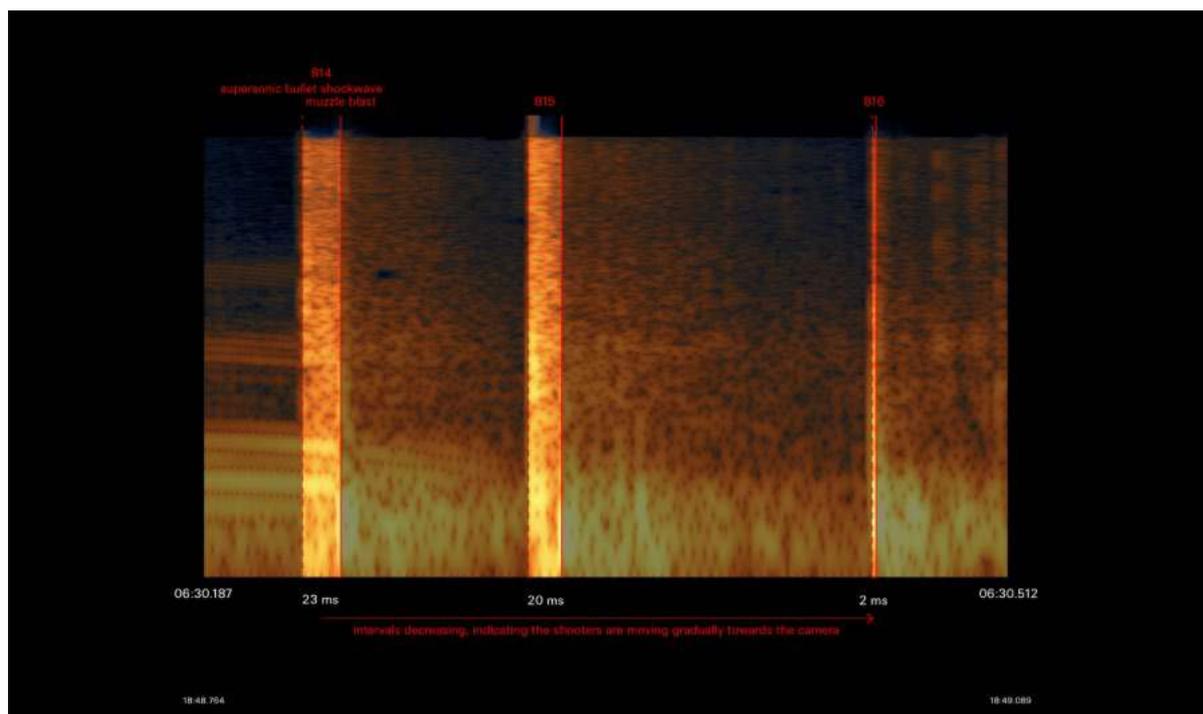


Figure A14: Spectrograph of gunshots number 814, 815 and 816, showing the decreasing interval between supersonic bullet shockwave and muzzle blast.

The decreasing interval between the sound of the supersonic bullet shockwave and muzzle blast, until both sounds are heard almost simultaneously, in the final 1 minute and 30 seconds of Refaat’s video indicate that the Israeli soldiers advanced towards the aid workers until arriving at their location, while continuously firing.

This analysis, together with the echolocation analysis, supports Asaad’s testimony on the Israeli soldiers’ movement, continuous gunfire, and arrival at his and his colleagues’ positions amongst the emergency vehicles.

### A.2.3 5:14 am: Close-range executions

#### [A.2.3.1 Synchronising Refaat’s video with Ashraf’s phone call](#)

Earshot could confirm Ashraf’s phone call overlapped with the final 42 seconds of Refaat’s video by matching the sound of 109 gunshots. Ashraf’s phone call continues for another 52 seconds, capturing 24 new gunshots (Figure A15). The synchronisation of the two recordings additionally matches Refaat and Ashraf’s final words, providing a crucial, unbroken account of the moment the Israeli soldiers arrive at the aid workers’ positions.

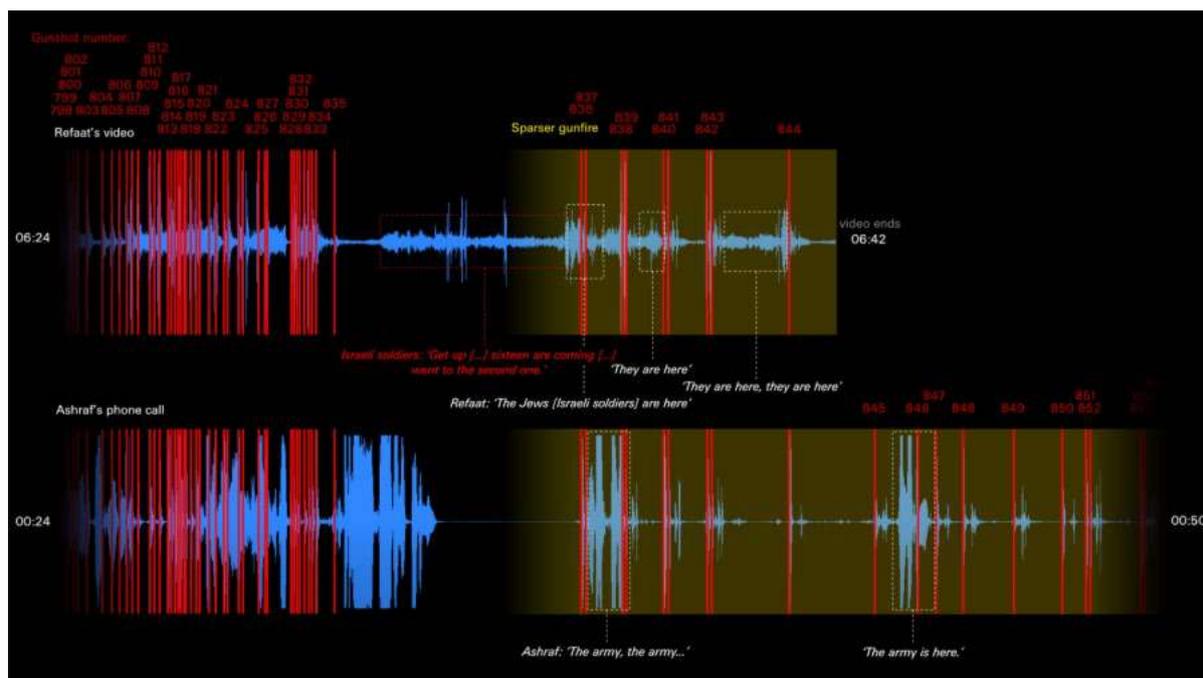


Figure A15: Synchronised audio from Refaat’s video with Ashraf’s phone call highlighting Refaat’s and Ashraf’s final words among the sound gunshots and approaching Israeli soldiers shouting military commands in Hebrew

### [A.2.3.2 Israeli soldiers surrounding the aid workers](#)

Between minute 06:30.780 and 06:42.500 in Refaat’s video the voices of multiple Israeli soldiers become clearly intelligible (Figure A15, para. A.2.3.1). These voices are heard across the left and right audio channels of the recording. Since the audio in Refaat’s video was recorded in stereo, the presence of Israeli voices across the left and right audio channels indicate that the Israeli soldiers are now surrounding Refaat and are close to his position.

### [A.2.3.3 Asaad’s testimony and Refaat and Ashraf’s final words](#)

In the synchronised audio of Refaat’s video and Ashraf’s phone call, Earshot identified both Refaat and Ashraf simultaneously announcing the arrival of the Israeli soldiers, under the sound of gunfire (Figure A15, para. A.2.3.1).

After Refaat’s video ends, Ashraf’s phone call continues, capturing the final time Ashraf announces the arrival of the soldiers. Following this final announcement, between minute 00:44.400 to 00:54.400, 17 gunshots are heard, together with handling noise, possibly caused by clothes or objects brushing against the phone’s microphone. This sound could be that of Ashraf’s final movements as he is holding his phone and is shot. The phone call continues for 40 seconds in relative silence, capturing the final 6 gunshots, without the sound of handling noise or Ashraf’s voice, suggesting he is lying motionless on the ground.

After Asaad witnessed the soldiers approaching the emergency vehicles from the elevated sandbank, he describes: *‘the soldiers came down, got close to [Ashraf and Refaat] and shot them from close range.’* When asked how many of the soldiers were firing these close-range gunshots and which aid workers were being targeted, Asaad replies *‘more than one soldier, each shooting different people.’*

Additionally, according to Asaad’s testimony, both Refaat and Ashraf were located within metres of each other, next to his and Refaat’s ambulance. It is therefore likely that Refaat and Ashraf were killed at close-range within seconds apart.

#### A.2.3.4 New echo patterns: soldiers positioned between emergency vehicles

Earshot identified a new pattern of muzzle blast echoes that suggest the final gunshots captured in Ashraf’s phone call are fired from in-between the emergency vehicles.

8 out of the 24 additional gunshots captured in Ashraf’s phone call contain new muzzle blast echoes, characterised by 2 to 3 echoes in quick succession, between 20 to 140 milliseconds after the muzzle blast (Figure A16).

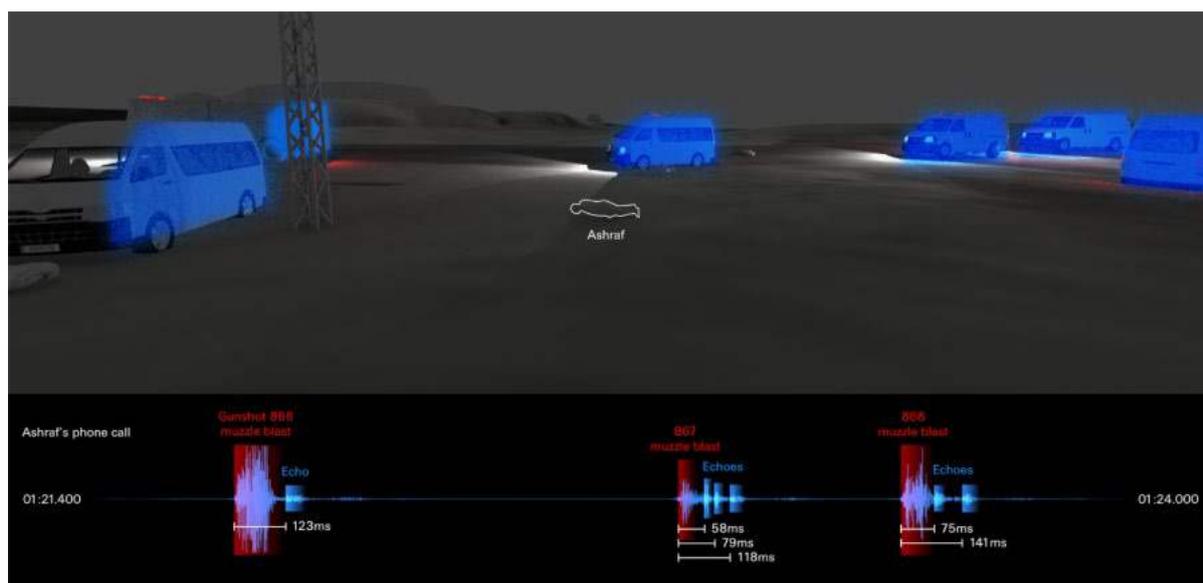


Figure A16: Illustration of the variation of early muzzle blast echoes in the gunshots heard on Ashraf’s phone call with the PRCS, and of the relation between this variation and the surfaces of the emergency vehicles likely causing these echoes.

These new muzzle blast echoes suggest the soldiers are firing from a position where a different set of surfaces identified from the previous echolocation analysis are reflecting the sound of the muzzle blast back to Ashraf’s phone.

If a sound source is within metres of a recording device as in the case of the Israeli soldiers during Ashraf’s phone call, an echo audible after 20 to 140 milliseconds indicates that the echo is reflecting on a surface between 3 to 24 metres of the recording device.

The only surfaces within a 24-metre radius of Ashraf’s position at the time of his phone call to the PRCS are the emergency vehicles themselves.

These echoes, while occurring consistently between 20 to 140 milliseconds after the muzzle blasts, change significantly across the 8 gunshots, varying in rhythm and intensity.

Paragraphs A.2.1.1 and A.2.1.3 established how changes in the position of a sound source, a recording device or a reflective surface affect the path travelled by an echo, and result in the echo arriving at the recording device earlier or later.

In Ashraf's phone call, the variation of the echoes across the 8 gunshots suggests the Israeli soldiers are moving and shooting from in-between the emergency vehicles, whose complex arrangement and orientation causes variations in the echoes' rhythm and intensity as the shooters are moving and changing their direction of gunfire.

The movement of Israeli soldiers in-between the vehicles is supported by the presence of an Israeli soldier's voice shouting '*Go, go, go, go, go!*', audible at minute 01:31.120, just before Ashraf's phone call ends. This is one of the few moments where the voice of an Israeli soldier is so close to the microphone as to provide clear speech intelligibility, further substantiating the findings that the Israeli soldiers are just meters away from the aid workers.

#### [A.2.3.5 Echolocation of gunshots 857, 858 and 862](#)

Between minute 00:50.560 and 00:53.840 of Ashraf's phone call Earshot identified the gunshots that most likely killed Ashraf, locating the shooter for one of these shots to a position within 1 to 4 metres away from him. Earshot made this conclusion through multiple, cross-corroborative streams of evidence.

Earshot's audio analysis established that by the time Refaat's video ends and Ashraf's phone call continues the Israeli soldiers are moving in-between the emergency vehicles. The position and movement of Israeli soldiers is supported by Refaat and Ashraf's final words announcing the soldiers' arrival, and Asaad's testimony where he witnesses the approach of the soldiers down the sand bank to in-between the aid workers, firing at close-range and executing Ashraf and Refaat. Asaad was positioned near Ambulance C at the time he witnesses Ashraf and Refaat's executions (Figure A18). The shooters therefore were located within the area of Asaad's field of view.

Given this evidence, Earshot analysed further the echoes of the 8 gunshots from paragraph A.2.3.4 in order to derive additional information on the shooters' positions. 3 out of the 8 gunshots - gunshots 857, 858 and 862 - contain 2 extremely clear echoes between 52 and 107 milliseconds following the muzzle blast. These gunshots contain some of the loudest echoes observed in all the 910 gunshots Earshot analysed from the recordings taken on the night (Figure A17).

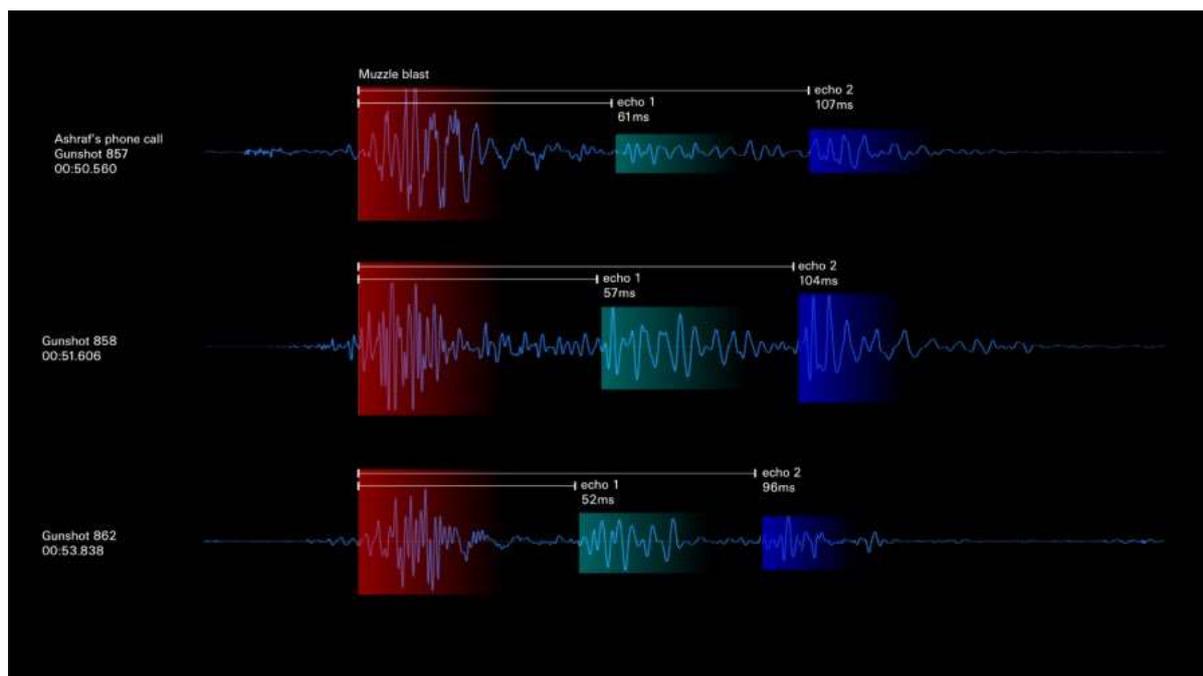


Figure A17: Waveform of muzzle blast and echoes for gunshots 857, 858 and 862.

These three gunshots occur within 3.2 seconds of each other, they have a similar profile (time interval between peaks) and acoustic characteristics (amplitude), suggesting they are fired from similar positions close to each other.

As mentioned in paragraphs A.2.1.2 and A.2.2.1, if the surface causing an echo is known, the interval in time between the muzzle blast and an echo can be used to estimate the shooter's location.

Paragraph A.2.3.4 established the only surfaces that can cause early echoes such as those identified in gunshots 857, 858 and 862, are the emergency vehicles themselves. Earshot used the positions and orientations of the 6 emergency vehicles in relation to Ashraf's phone at the time of the recording in order to calculate which vehicles were most likely responsible for the pairs of echoes.

The complexity of the arrangement and orientation of the 6 emergency vehicles results in several permutations of reflective surfaces. Earshot simulated all the possible permutations in order to identify the pair of vehicles that: 1) produce echoes between 52 to 107 milliseconds; and 2) are orientated so as to reflect the sound of a gunshot back to Ashraf.

Earshot could exclude Ambulances C, A and the PCD firetruck, as these vehicles are all orientated in such a way as to not reflect sounds directly to Ashraf from positions fitting the time intervals of 52 to 107 milliseconds.

This leaves Ambulance B, D and the PCD Ambulance. Since Ambulance B can only produce echoes of under 50 milliseconds, Earshot therefore finds it more likely that the echoes are being produced by Ambulance D, causing echo 1, and the PCD Ambulance, causing echo 2.

Earshot identified an area from which a gunshot would produce echoes of 61 and 107 milliseconds (gunshot 857), 57 and 104 milliseconds (gunshot 858), and 52 and 96 milliseconds (gunshot 862)

(Figure A18). These three shooting positions are within the line of sight from the position where Asaad testified witnessing his colleagues' executions.

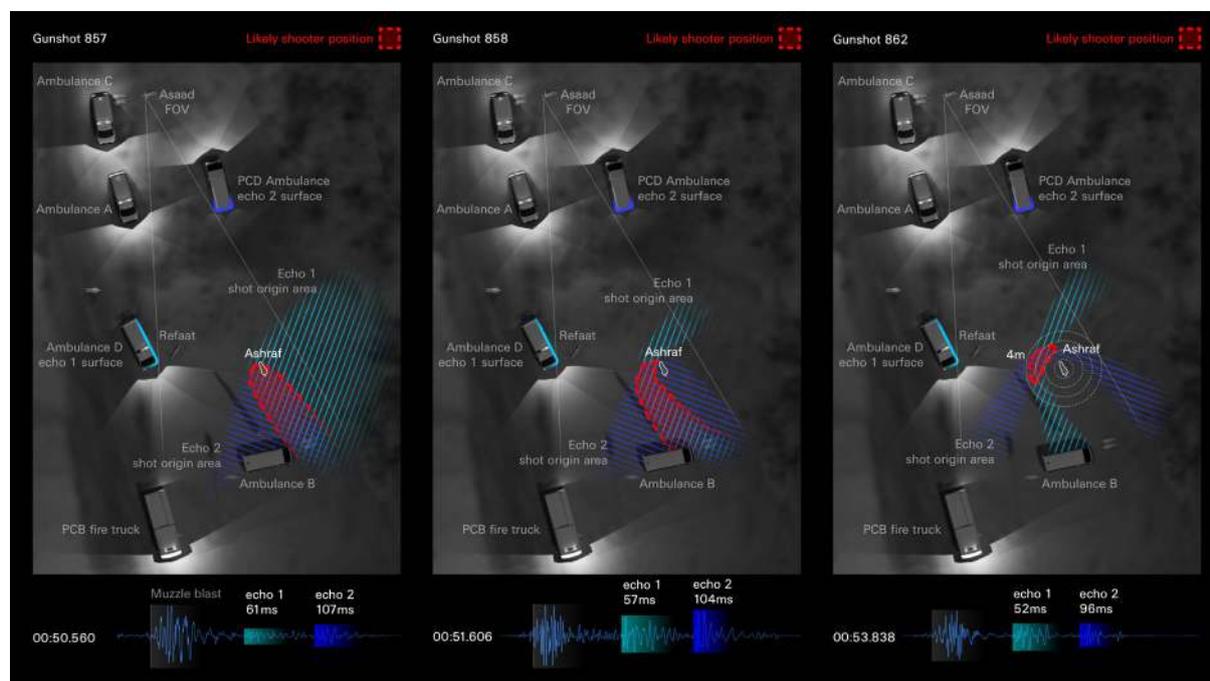


Figure A18: Echolocation of likely shooter area for gunshots 857, 858 and 862.

These three gunshots are heard 6 seconds after Ashraf's final words announcing the arrival of the Israeli soldiers to his position. After each of these shots, the sound of handling noise of the phone can be heard. As mentioned in paragraph A.2.3.3, this sound could be that of Ashraf's final movements as he is holding his phone. The last time we hear this sound is at minute 00:53.840, coinciding with gunshot 862. During the remaining 40 seconds of this recording Ashraf's voice is no longer heard nor is there any other handling noise. This, in combination with the likely proximity of the gunshots to Ashraf, suggest that one of these three shots is most likely responsible for his death.

Through multiple streams of evidence Earshot concludes that the gunshot that kills Ashraf is most likely among gunshots 857, 858 and 862, with the shooter firing as close as 1 to 4 metres from Ashraf.

#### [A.2.3.6 Audio ballistic analysis: Sparser gunfire and disappearing supersonic bullet shockwave](#)

The final 9 gunshots in Refaat's video and the additional 24 gunshots captured in Ashraf's phone call exhibit a much sparser pattern of shooting compared to the intense gunfire heard before the Israeli soldier's approach to the vehicles and aid workers (Figure A15, para. A.2.3.1). This change from sustained, intense gunfire to sparse, single gunshots, suggests a pattern of close-range, targeted gunfire.

An audio ballistic analysis of the final gunshots in Refaat's video shows a correlative change to the new muzzle blast echoes identified in Ashraf's phone call in paragraph A.2.3.4. This change supports further

the conclusion that the Israeli soldiers were firing at the aid workers from close-range, in-between the emergency vehicles.

The final gunshot in Refaat's video, gunshot 844 at minute 06:41.418, is the last instance a supersonic bullet shockwave is heard. The additional 24 gunshots in Ashraf's phone call contain only the sound of the muzzle blast.

93% of gunfire heard before this moment (789 out of 844 gunshots) contained audible supersonic bullet shockwaves. As established in paragraph A.1.1, the presence of a supersonic bullet shockwave indicates that a recording device is in the direct line of fire.

Paragraph A.2.2.2 outlined how the gradual decrease in the interval between the supersonic bullet shockwave and muzzle blast, until the two sounds are audible at the same time, indicates the shooter has approached the recording device until reaching its position.

The disappearance of the supersonic bullet shockwave in the final 24 gunshots in Ashraf's phone call therefore indicates either that the shooter is firing from extremely close to Ashraf, or that Ashraf's phone is no longer in the line of fire. This second scenario can either be caused by the shooter moving past Ashraf's location, or by the shooter being extremely close and firing the final 24 gunshots in a direction away from Ashraf's position.

Multiple streams of evidence, namely a new pattern in gunfire density, echolocation and audio ballistic analysis, corroborate both Refaat and Ashraf's final words and Asaad's witness statements on the arrival of the Israeli soldiers and the close-range executions of the aid workers.

#### **A.2.4 7:13 am: Sustained military operations in the area and identification of Israeli soldiers**

##### **A.2.4.1 Identifying the weapon: Spike LR guided missile**

A recording of Asaad's phone call to the PRCS headquarters was sent to Earshot by the PRCS in five different clips. Earshot analysed the sound of the explosion at minute 01:17.020 in clip 1 and found a close match with the sonic profile of a spike LR missile.

The spike LR is a guided missile fired from a 'vehicle-mounted' or a 'man-mounted' missile launcher and is produced by Israeli military technology company Rafael Advanced Defense Systems.<sup>47</sup>

The missile has a sequence of launch that produces a distinct 3-phased sonic profile (Figure A19). Earshot analysed open-source material of a known use of a Spike LR missile<sup>48</sup> and identified its 3-phased sonic profile. First, the missile is expelled from the rocket launcher, which produces a muzzle blast. Second, shortly after exiting the launcher, the missile's own flight engine turns on,<sup>49</sup> producing a second blast less than a second after the first muzzle blast. As the missile is guided to target its jet engine produces a continuous roar. This roar gets quieter as the missile flies in the air, away from the

<sup>47</sup> <https://www.rafael.co.il/system/spike-lr2/> (Accessed November 3, 2025)

<sup>48</sup> <https://www.youtube.com/watch?v=S8rNb6kSSW0> (Accessed November 3, 2025)

<sup>49</sup> <https://www.outono.net/elentir/2023/04/25/the-complete-sequence-of-the-launch-of-a-spike-lr-missile-by-spanish-legionnaires/> (Accessed November 3, 2025)

camera and towards target.<sup>50</sup> The final sound typically audible is the sound of the missile making impact on target.

Earshot analysed the explosion heard on Asaad’s call and found the same sequence of sounds. First, the sound of a muzzle blast as the missile is expelled from the rocket launcher. Second, the sound of the missile’s ignition, categorised by a blast 30 milliseconds later. This second blast is followed by the sound of the missile in flight. This sound increases in intensity 340 milliseconds after the first muzzle blast, quietening down shortly after, suggests the missile is flying towards and past Asaad’s phone, while he calls the PRCS headquarters.

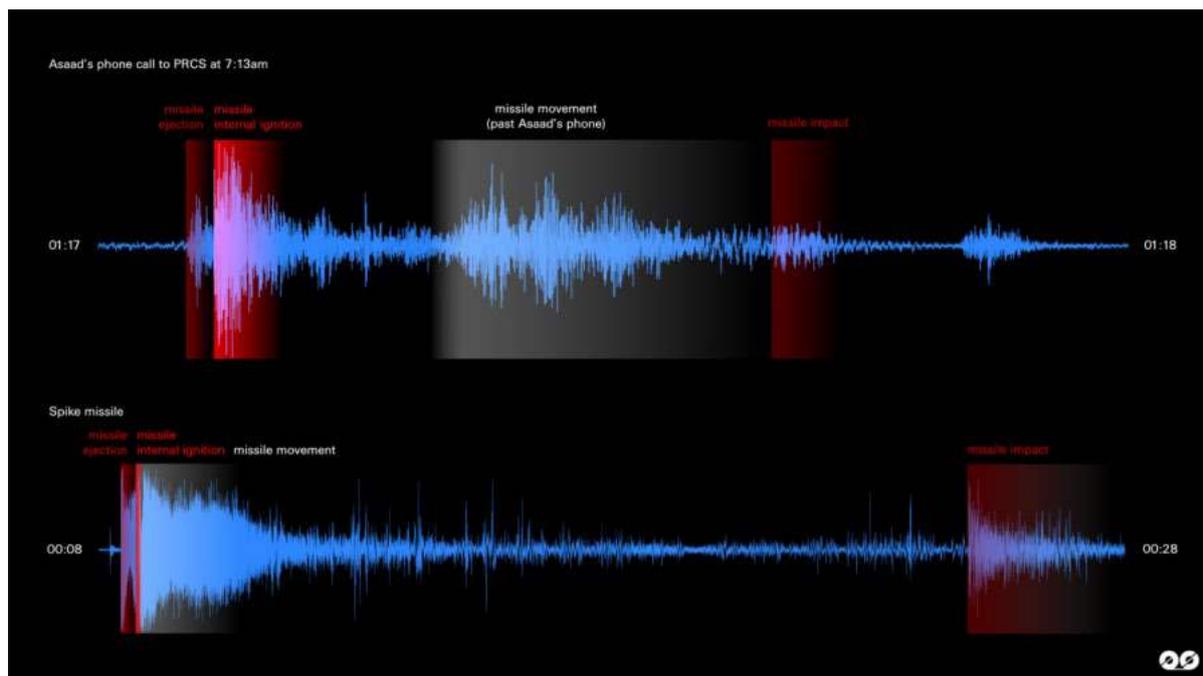


Figure A19: Sonic profiling and comparative analysis of the missile heard in Asaad’s phone call and a known recording of a Spike LR missile in 2020.

#### [A.2.4.2 Confirmed use of heavy weaponry over 2 hours after the attack](#)

Asaad’s testimony describes the continued military activity in the area over two hours after the attack on his convoy, including the use of heavy weaponry: *‘I saw a soldier on one knee, with the launcher on his shoulder. From the mound. (...) When the [UN] vehicle entered I was actually on the phone [with the Palestinian Red Crescent]. [They were] asking me if there were any cars moving, and I told them yes, the UN vehicle. As soon as I told him yes, they hit the vehicle.’*

While Earshot could not confirm that the sound of the explosion heard in Asaad’s phone call is the same incident as the missile strike witnessed by Asaad, the presence of each of the sounds typically associated with an LR spike missile in Asaad’s phone call confirms the use of heavy weaponry on the night, over two hours after the attack, in close proximity to the emergency vehicles and aid workers.

<sup>50</sup> <https://www.youtube.com/watch?v=S8rNb6kSSW0> (Accessed November 3, 2025)

### A.2.4.3 Translated speech between Israeli soldiers and soldiers' names

Earshot identified multiple voices of Israeli soldiers in clip 1 and 3 of Asaad's phone call with the PRCS. Through audio enhancement, Earshot was able to recover a transcript of the soldiers' speech and identify three soldiers involved in the incident: Elias, Yotam, and Amatzia.

The following is a translation of the soldiers' speech from Hebrew to English:

**Clip 1:**

00:05 – 00:07: *Lalas did you finish?*

00:07 – 00:10: *Then go replace them, we will put the guns on them and you can bring their bags.*

00:36 – 00:38: *What's happening Yotam?*

00:38 – 00:42: [Unintelligible] *you don't drop cover. Go first over there, give cover, get their head stuck into something.* [sic]

01:17 – 01:18: [sound of explosion, likely Spike LR missile]

03:36 – 03:38: [mechanical sound]

**Clip 3:**

00:32 – 00:37: *Elias wait a second so that he can see you, the one passing with a* [unintelligible].

00:44 – 00:46: *I'm on* [unintelligible] *right now.*

00:57 – 00:58: *It's Amatzia.*

00:58 – 00:59: *All of you come.*

01:30 – 01:32: *Let's remove the* [unintelligible].

01:42 – 01:48: [sound of engine revving and vehicle movement]

02:25 – 02:27: *Did everyone already leave?*

02:27 – 02:28: *What?*

02:28 – 02:29: *Did everyone already leave?*

02:29 – 02:31: *Down here, I can't* [unintelligible].