23038 Spy balloons: modern technology has given these old-fashioned eyes in the sky a new lease of life

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The US military has now shot down four high-altitude objects that had entered American and Canadian airspace, raising questions about their purpose and origin.

The first of these objects, a Chinese balloon, was downed by a fighter jet on 4 February. It is believed to have supported a signals intelligence collection payload.

A further three objects were downed between February 10 and 12.

Signals intelligence, or "sigint", refers to electronic data, which could consist of conversations, written messages or data from weapons or radar systems. Sigint is normally collected by satellites, but can also be gathered from aircraft flying in international airspace.

The US military has been developing signals – electronic data transmissions – with a low probability of intercept. This is making sigint collection by both Chinese and Russian spy satellites difficult.

Let's consider the high-altitude balloon that was shot down on February 4. By tracing this object's path over the US, it can be seen to have passed several highly sensitive US defence installations, including silos for nuclear-capable intercontinental ballistic missiles.

Thus, a balloon that can remain undetected would be an ideal platform to augment the collection of sigint by both satellites and aircraft.

Remaining undetected for a significant period is a key requirement to success.

One possible answer lies in the design of ground-based and airborne early warning system (AEW) radars. To reduce clutter on the radar, objects that are static such as mountains and towers are removed from the radar returns by making use of a natural effect known as "Doppler shift".

A balloon or inflatable object could be travelling at a velocity slower than the Doppler threshold and thus remain undetected.

This shortfall in detection capability was recognised by NORAD (North American Air Defense Command) and radars have been reset to see very low velocity objects.

A further difficulty with detection is the material used for balloons or objects. Plastics and synthetic inflation fabrics have no or very low radar reflectivity. The balloon that started the current controversy in the US was first discovered visually and reported, rather than detected by air defence systems.

But the more recent discoveries over Canada and Alaska resulted from high-intensity surveillance. The key question will be whether the objects were designed to penetrate the US defence system to gather better signals intelligence, or whether they were a test of US air defence systems.

It could, alternatively, be just a nuisance strategy.

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