

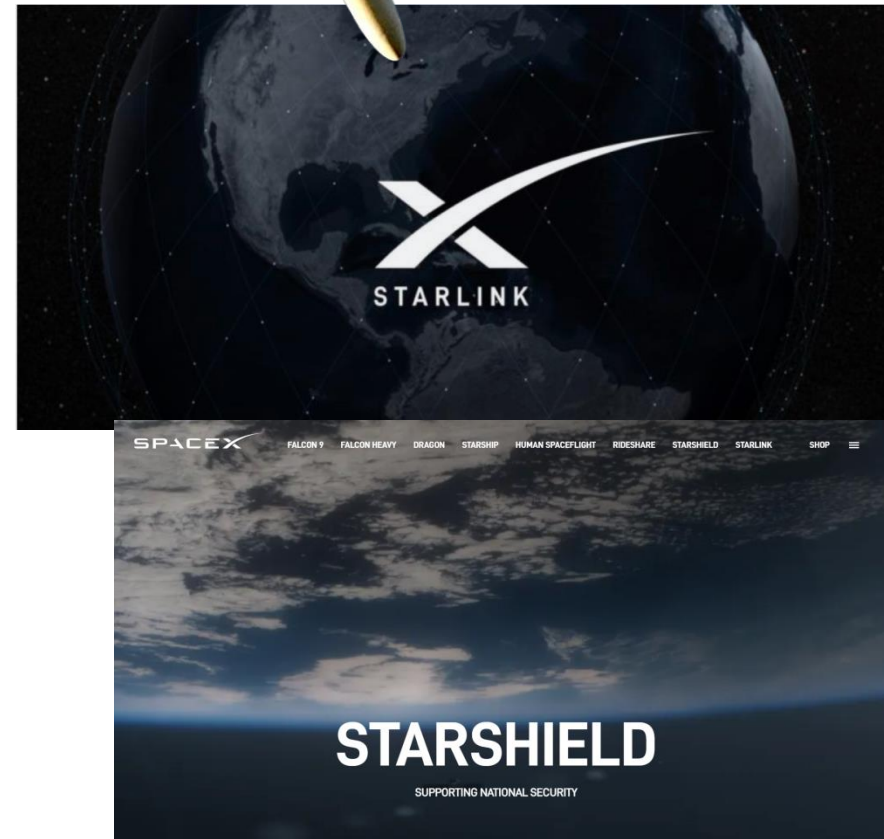
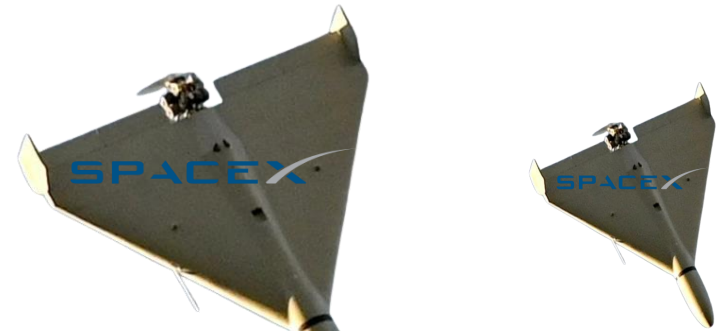
SpaceX could make revolutionary war drones and help protect the free world against tyranny

#7

First published February, 2023

Presentation chapters

1. Do a better future require better weapons?
2. What is the Iranian Shahed drone?
3. Why is the Shahed drone so great?
4. Why SpaceX is uniquely positioned to make the Shahed drone even more revolutionary
5. Target acquisition and evaluation:
How much can you see from space?
6. How inexpensive autonomous drones will revolutionize modern warfare
7. Why SpaceX should also make drone weapons and spy satellites
8. Concluding remarks



Chapter 1

Do a better future require better weapons?




Do a better future require better weapons?

- ✓ **Short answer is a better future** do not require better weapons >if< humanity was only composed of good people/countries that only interacted with other people/countries based on voluntary and mutually beneficial understandings/agreements
- ✓ **In a world with only good people/countries** no war would ever happen and weapons would not be needed
- ✓ **Problem is humanity has many evil people/countries** that are willing to exploit other people/countries against their will using violence and weapons to force these people/countries to do things they would not want to do voluntarily
- ✓ **Russia trying to steal people and land from Ukraine using military force** is a great example of a mostly evil country trying to exploit a mostly good country




Do a better future require better weapons?

- ✓ **The hard reality is that countries that are mostly good** needs more and better weapons than the mostly evil countries or else these mostly good countries would be conquered and exploited by the mostly evil countries
- ✓ **The mostly evil countries will go to war the instant** they judge they have a good chance of winning so that the cost and risk of war is less than the spoil from conquering other people and territory
- ✓ **Mostly evil countries have no empathy for their victims or the suffering of their own soldiers** who are ordered to war
- ✓ **If you doubt that ask yourself** if you think Putin or his inner circle cares about the suffering of the Ukrainians or the soldiers in the Russian army
- ✓ **The >only way< for mostly good countries to prevent war** and not getting attacked is to have more and better weapons than the countries that are mostly evil. No one like this answer to prevent war but it is the truth
- ✓ **This is why SpaceX being a company incorporated in a mostly good country aka USA with a mostly good CEO aka Elon Musk** can help to create a better future for humanity by making superior weapons in defense of mostly good countries like NATO & Ukraine



“The Only Thing Necessary for the Triumph of Evil is that Good Men Do Nothing”, Edmund Burke



“We know only too well that war comes not when the forces of freedom are strong, but when they are weak. It is then that tyrants are tempted.”

Ronald Reagan, Republican National Convention, July 17 1980



Sources/attribution for previous slides

- **Attribution war picture slide 4:** https://www.freepik.com/free-photo/city-tornado-doomsday-scene-illustration_14402247.htm#&position=11&from_view=author>Image by liuzishan
- **Attribution Ukraine flag in shape of Ukraine:** https://www.freepik.com/free-vector/hand-painted-ukraine-map-flag-colours_25033827.htm#query=ukraine%20flag&position=1&from_view=search&track=sph>Image by kjpargeter



Chapter 2

What is the Shahed drone?



Drone Weapon Specks: Shahed 136

- ✓ **Shahed is an attack drone made by Iranian company HESA** and officially entered service in the Iranian army in December 2021
- ✓ **Shahed specks and looks** are almost identical to Israeli drone Harpy from 1989 see picture below
- ✓ **Current Iranian production capacity:** 150 units per month
- ✓ **Buyers:** Russia has bought 2400 of them for use against Ukraine
- ✓ **Weight:** 200 kg with a 45 kg warhead (HIMARS warhead is 120 kg and rocket is 300 kg)
- ✓ **Size:** 3.5 meters long and wingspan is 2.5 meters wide (HIMARS rocket is 227 mm and it is 3.96 m long)
- ✓ **Flight height:** 60 to 4,000 meters
- ✓ **Cruising speed:** 185 km/h (HIMARS speed 3062 km/h)
- ✓ **Range:** 1000 km possibly 2500 km but if true with much smaller warhead (HIMARS range is 70 km for the version Ukraine got)



Propulsion - Frame/body

- ✓ **Propulsion is low tech propeller design** using an old combustion engine 50hp Limbach L550E developed by VW and used in VW Beetles from 1936 to 2006
- ✓ **The Iranian Shahed frame and body use a lot of composite materials that are not suited for mass production** by the 10s or 100s of thousands per month
- ✓ **A design using stamped metal sheets and metal frame** is needed for mass production of drone by the 10s or 100s of thousands per month
- ✓ **Metal drone would weight more** so range will take a toll
- ✓ The 1000 km range of the composite Shahed would probably drop to 600 km with an inexpensive metal drone
- ✓ Iran's need for range is higher than Ukraine's need for range



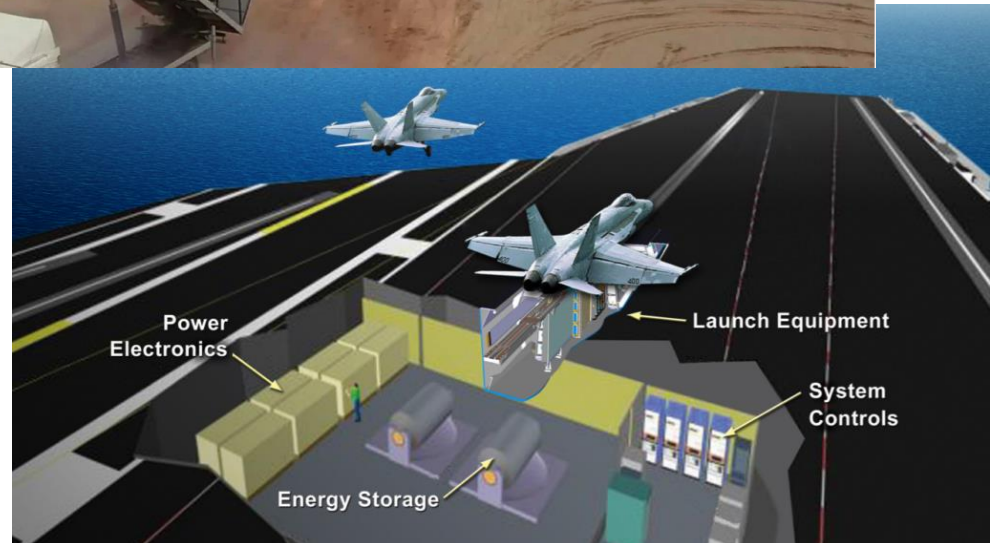
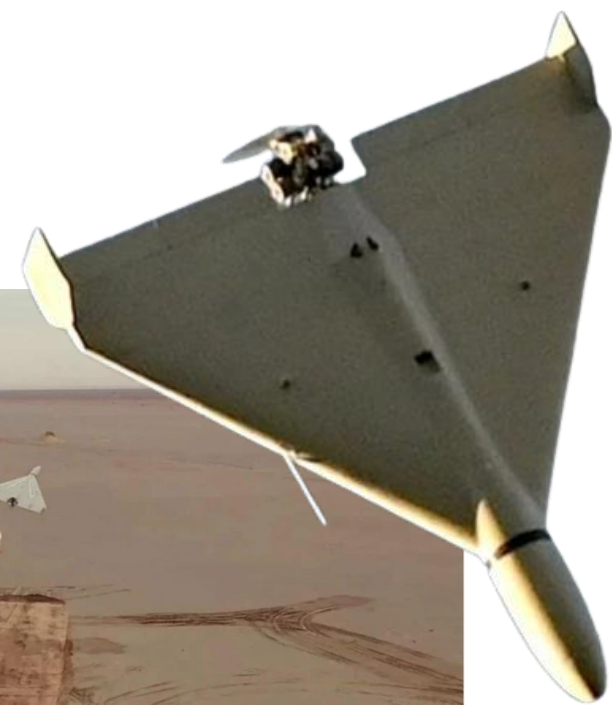
Sources/attribution for previous slides

- **Spec sheet for Shahed 136 and lots of other info:** <https://mezha.media/en/2022/10/05/shahed-136-a-nasty-enemy-uav-that-terrorizes-ukrainians/>
- **Images attribution:** <https://mezha.media/en/2022/10/05/shahed-136-a-nasty-enemy-uav-that-terrorizes-ukrainians/>
- **Monthly production capacity in Iran for Shahed-136 is 150 units per month:**
<https://www.technology.org/2022/11/05/reserves-of-shahed-136-drones-ending-in-russia-whats-next/>
- **Russia ordered 2400 Shahed drones from Iran:** <https://mil.in.ua/en/news/russia-ordered-2-400-shahed-136-kamikaze-uavs-from-iran/>
- **HIMARS M31 warhead weight 120 kg and other specs:** http://www.military-today.com/artillery/m270_mlrs.htm
- **Speed of HIMARS M31 rocket is 3063 km/h:** <https://kyivindependent.com/national/why-is-russia-so-vulnerable-to-himars-in-ukraine>
- **Israeli Harpy drone:** https://en.wikipedia.org/wiki/IAI_Harpy



Take off

- ✓ Iranian Shahed allegedly takes off using expendable solid propellant rocket mounted below
- ✓ **SpaceX improvement #1:** Make catapult launcher powered by an electric motor winding-up a pull cable for drone (aka air-craft carriers)
- ✓ **Catapult save the cost** of the launch rocket and also smaller thermal signature (spy satellites can see rocket launches)
- ✓ **Electric catapult launcher system need to fit a standard 40 foot shipping container** for minimizing battlefield logistics hurdles
- ✓ **SpaceX improvement #2:** As an alternative launch mode use a 3 wheel landing gear that also mounts on the launch-rocket mount below the drone and that can be dropped off like the rocket
- ✓ **If landing gear is kept on during flight** the drone becomes reusable



Is Shaged fired directly from truck?



- Attribution video of Shaged launch: <https://www.youtube.com/watch?v=4mXTc5AEbc8>

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Sources/attribution for previous slides

- **Images attribution for Shahed lunch picture:** <https://mezha.media/en/2022/10/05/shahed-136-a-nasty-enemy-uav-that-terrorizes-ukrainians/>
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- **Solid propellant rocket:** https://en.wikipedia.org/wiki/Solid-propellant_rocket
- **Attribution video of Shahed launch:** <https://www.youtube.com/watch?v=4mXTc5AEbc8>



Chapter 3

Why is the Shahed drone so great?



Why great? Low manufacturing costs

- ✓ **Shahed only weights 200 kilo (440 pound)** and is far simpler to build than a cheap automobile at 1,200 kilo (2645 pound) when made in metal like an automobile
- ✓ **The 200 kg composite drone** is likely distributed by 45kg for warhead, 100 kg of fuel and 55kg for the drone itself
- ✓ A 200 kg metal drone may be 45kg warhead 60kg of fuel and 95 kg for drone itself
- ✓ **Cost of composite Shahed: 60,000 USD** in low volume mostly hand build as the Iranian version
- ✓ **SpaceX improvement #3:** SpaceX could make a mass produced Shahed in metal like an automobile for 6,000 USD
- ✓ See my YouTube video #4 on Shahed cost and engineering



Why great? Shahed cost compared

- ✓ **Cost of SpaceX Shahed, 600 km range with 45 kg warhead and speed 185 km/h: 6000 USD**
- ✓ **Cost of US Tomahawk cruise missile with 1600 km range, 450 kg warhead and 913 km/h speed: 2 million USD or the same as 333 Shaheds**
- ✓ **Cost of Himars M30/M31 rocket with 70 km range, 120 kg warhead and 3062 km/h speed: 110,000 USD or 18 Shaheds**
- ✓ **Cost of 155 mm guided Excalibur artillery shell with 70 km range, warhead 48 kg but only 4? kg of explosives and 3157 km/h speed: 68,000 USD or 11 Shaheds**
- ✓ **Cost of 155 mm artillery shell 43 kg/7 kg of explosives speed 3157 km/h : 1,000 USD but need 100 to hit a target within 30 to 40 km so 100,000 USD or 17 Shaheds**
- ✓ **Cost of 120 mm tank shell is 4,000 USD but you need to fire 10 times to hit a target within 3 km so 40,000 USD or 7 Shaheds**



Why you need 100 shells to hit anything



The above Maxar WorldView-2 image shows fields northwest of Slovyansk, Ukraine, peppered with artillery craters on June 6, 2022.

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Sources/attribution for previous slides

- HESA Shahed 136 and unit cost of 10,000 to 60,000 USD: https://en.wikipedia.org/wiki/HESA_Shahed_136
- My own video #4 where I estimate costs of 6000 USD for Shahed in mass production made of metal like an automobile: <https://youtu.be/mhLICBffOJg>
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- HIMARS M31 warhead weight 120 kg and other specs: http://www.military-today.com/artillery/m270_mlrs.htm
- HIMARS speed of rocket 3062 km/h: <https://kyivindependent.com/national/why-is-russia-so-vulnerable-to-himars-in-ukraine>
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- 155 mm Excalibur artillery: https://en.wikipedia.org/wiki/M982_Excalibur
- 68,000 USD cost of Excalibur: <https://root-nation.com/en/articles-en/weapons-en/en-155mm-m777-howitzer-and-m982-excalibur/>
- Cost of tank shell is 4000 USD: <https://www.quora.com/How-much-does-a-tank-round-cost>
- Range to hit something is 3 km for tank: <https://man.fas.org/dod-101/sys/land/docs/4lastmbt.pdf>
- Satellite images from Maxar: <https://blog.maxar.com/for-a-better-world/2022/aviation-week-names-maxar-a-2022-laureate-award-winner>



Why great? Efficient delta wing aerodynamics

- ✓ **A brilliant design feature of the Shahed** is its use of a cropped delta wing design (IMO the cropped design with perpendicular flap solve problem with flow separation at high angles of attack at low speed)
- ✓ **Delta wing design is know to be more efficient than a traditional airplane design** having a big fuselage with wings in the middle and flight control wings at the back
- ✓ **Traditional design is only used** because 1) the big fuselage is needed to accommodate passengers and cargo and 2) it is more weather robust
- ✓ **Delta wing is best choice for making a long-range, affordable suicide drone** because it 1) obviously has no need for a large fuselage and 2) safety of flight is not a big issue either



Why great? Simple affordable controls



From pictures to the right and below it looks that engine is mounted on a gimbal for control of aircraft



From picture to the right it is easy to see the drone also use 4 actuators to move 4 control flaps at back of delta wing



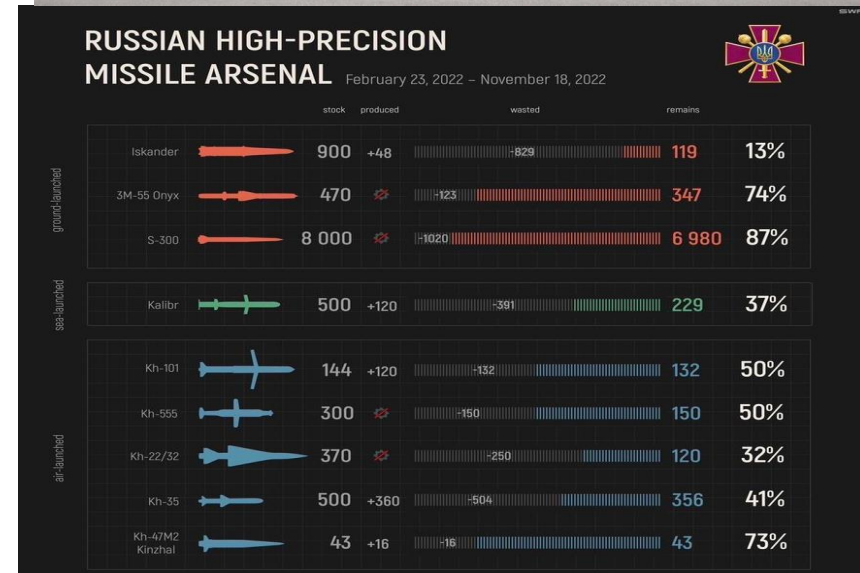
Why great? Affordable and robust navigation

- ✓ Shaded navigate using a combination of **satellite navigation** signals (US (GPS), EU (Galileo), Russia (GLONASS) and China (BeiDou)) and **inertial navigation**
- ✓ If satellite signal is jammed drone can still find its target using **inertial navigation that uses motion sensors (accelerometers), rotation sensors (gyroscopes) and a computer to calculate** its new positions given its last known satellite position and subsequent movement of drone
- ✓ **For more precision** barometric altimeter and/or speed measuring devices may be used
- ✓ **Iranian Shahed use public GPS signals that should be able to** hit target at ± 4 meters if it has a satellite signal and it may go to ± 40 meters if it does not have a satellite signal and has not lost its satellite signal say within say 30 kilometers from target
- ✓ **SpaceX improvement #4:** Use military GPS signal to increase accuracy to 30 cm (1 foot)
- ✓ **SpaceX improvement #5:** Make variant that also can target radar and jamming signals and if signal is turned off it hit a secondary target instead using GPS



Why great? Can overwhelm any missile air defenses

- ✓ The low cost of 6000 USD for Shahed means it can overwhelm any currently known air defense by sheer number superiority
- ✓ 1 million Shahed drones will cost only 6 billion USD (or what NATO and EU spend every month aiding Ukraine's defenses)
- ✓ Even if you used the entire stock of NATO's anti-aircraft missile systems (short, mid & long-range) you would only be able to shoot down at most 50,000 Shaded drones
- ✓ Russia's prewar stock of anti-aircraft missiles was about 1/3 of NATO stocks
- ✓ Also short-range anti-aircraft missiles start at 120,000 USD for Stinger missile, 1.2 million USD for mid-range NASAMS and 3 million USD for long-range Patriots
- ✓ Obviously shooting down 6000 USD drones with weapons costing 20X to 500X more is not sustainable in warfare



Why not great? Slow speed/strong radar signature

- ✓ **The Shahed drone** is easy to spot on a radar and its flight speed is a slow 185 km/h
- ✓ **The currently most affordable way to shoot down such a drone is to use a radar controlled anti-aircraft gun** that either 1) shoots a cloud of say 100 bullets towards target or 2) use a few anti-aircraft rounds that explode when near target
- ✓ You still need to spend several thousands of USD worth of ammunition per drone kill
- ✓ **The Shahed's flight height is 4000 meter** and at that altitude most anti-aircraft guns cant reach it
- ✓ **Valuable targets can be protected using anti-aircraft guns that can engage the Shaheds cost effectively when they are within 3 km of target**
- ✓ **At 3 km firing range you have 58 seconds to destroy them**
 $= 3\text{km} / ((185\text{km/h} / (60\text{min} * 60\text{sec}))$
- ✓ **Best attack strategy for Shahed is to attack in large swarms at night so only radar controlled anti-aircraft guns can see them** and use enough Shaheds to overwhelm the capacity of the anti-aircraft guns to shoot them down within the 58 seconds they can be engaged
- ✓ **SpaceX improvement #6:** Make attack angle of Shahed programmable to make explosive proximity fused anti-aircraft rounds the least effective by Shaheds attacking the same target simultaneously from all sides or 360 degrees

German Gepard 35mm anti-aircraft gun, with 320 rounds and range 3.5 km



Why not great? Slow speed/strong radar signature

- ✓ The Shahed is low speed 185 km/h so another possibility is to use helicopters and airplanes with machine guns to shoot them down
- ✓ The advantage of that is that you can engage the Shaheds over much longer time like several hours because at 185 km/h it takes over 3 hours for Shahed to fly 600 km
- ✓ But a problem with today's jets and helicopters is that they only carry enough bullets to make 2 or 3 successful kills. They were not designed to counter hundreds of attacking Shaheds
- ✓ Moreover, the Ukrainian air force have had little success in shooting down the Shaheds with airplanes because at night when they are attacking they can't see them on the aiming gear they have for their gun
- ✓ "Each of the types of MiG-29 onboard weapons has its own shortcomings in certain conditions of hunting for Shaheds. For example, the on-board 30-mm cannon is effective only if the interception takes place during the day and the Shahed is in line of sight."
- ✓ NATO airplanes and helicopters should have the needed aiming gear to be able to shoot down a Shahed using their machine gun

An AH-64E Apache attack helicopter



F35: 25mm gun 220 rounds



Sources/attribution for previous slides

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- Images: <https://mezha.media/en/2022/10/05/shahed-136-a-nasty-enemy-uav-that-terrorizes-ukrainians/>
- More images: <https://eurasianimes.com/russia-has-exhausted-its-favorite-weapon-to-strike-ukraine/>
- Spec sheet for Shahed 136 and lots of other info: <https://mezha.media/en/2022/10/05/shahed-136-a-nasty-enemy-uav-that-terrorizes-ukrainians/>
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- Inertial navigation system that can be used when GPS is not available: https://en.wikipedia.org/wiki/Inertial_navigation_system
- Sources saying the Shahed 136 use a combination of GPS and inertial navigation: <https://www.quora.com/How-are-the-Shahed-136-drones-guided-GPS-Inertial-What-are-the-possibilities-for-jamming-them>
- Altimeter to measure altitude, the distance of a point above sea level: <https://education.nationalgeographic.org/resource/altimeter>
- Stinger short range anti aircraft missile has max altitude of 3800 meters: https://en.wikipedia.org/wiki/FIM-92_Stinger#:~:text=It%20has%20a%20targeting%20range,at%20up%20to%203%2C800%20m.
- Cost of Stinger short range anti-aircraft missile is 120,000 USD: https://en.wikipedia.org/wiki/FIM-92_Stinger
- Cost of one mid-range NASAMS anti aircraft missile is 1.2 million USD: <https://mezha.media/en/2022/08/25/2-9-billion-for-weapons/>
- The Patriot anti-aircraft missile NATO's most common has been made in over 10,000 units: https://en.wikipedia.org/wiki/MIM-104_Patriot
- The Patriot anti-aircraft missile NATO's most common cost 3 million USD per missile: https://en.wikipedia.org/wiki/MIM-104_Patriot
- Russian rocket arsenal: <https://twitter.com/oleksiireznikov/status/1594998365170896896>
- 20 to 30 mm bullets cost from 15 to 80 USD a piece: <https://www.quora.com/How-much-would-a-bullet-cost-to-military>
- How proximity fuses work for say explosive anti-aircraft rounds (they use radar or electronically set timer): <https://www.quora.com/How-do-proximity-fuses-work-compared-to-a-timed-fuze-How-cost-effective-are-they-Artillery-and-such>
- Attribution video Gepard: <https://www.youtube.com/watch?v=4mXTc5AEbc8>
- F35 220 rounds of 25 mm bullets: <https://www.businessinsider.com/marine-f-35-damaged-by-round-fired-from-own-cannon-2021-3?r=US&IR=T#:~:text=The%20Air%20Force%20F%2D35As,magazine%20in%20about%204%20seconds.>
- Ukraine air planes and helicopters cant see Shahed at night: https://en.defence-ua.com/analysis/how_difficult_is_it_to_shoot_down_the_shahed_136_on_the_mig_29_what_factors_make_the_task_complex-5147.html



Chapter 4

Why SpaceX is uniquely positioned to make the Shahed drone even more revolutionary



SpaceX can make the Shahed far more effective

- ✓ Previous slides mentioned 6 things that SpaceX could do to make the Iranian version a more effective weapon
- ✓ There are many more improvement SpaceX can make but lets start by refreshing our memory
- ✓ **SpaceX improvement #1:** Make catapult launcher powered by an electric motor winding-up a pull cable for drone (aka air-craft carriers). Make catapult system fit in a standard 40 foot container
- ✓ **SpaceX improvement #2:** As an alternative launch mode use a 3 wheel landing gear that also mounts on launch rocket mount below drone
- ✓ **SpaceX improvement #3:** SpaceX could make a mass produce Shahed in metal like an automobile for 6,000 USD. This is the most important improvement
- ✓ **SpaceX improvement #4:** Use military GPS signal to increase accuracy to 30 cm (1 foot)
- ✓ **SpaceX improvement #5:** Make variant that also can target radar and jamming signals and if signal is turned off it hit a secondary target instead using GPS
- ✓ **SpaceX improvement #6:** Make attack angle of Shahed programmable in order to make anti-aircraft guns the least effective. Specifically, the Shaheds attack the same target simultaneously from all sides or 360 degrees
- ✓ **SpeceX improvement #7:** Decrease wingspan of the Shahed to 2.38 meter so they can fit the 2.43 meter width of a standard shipping container (12 would fit a 40ft). Will make the battlefield logistics much simpler. Iranian Shahed is 2.5 meters wide



SpaceX can use Starlink for Shaded communication



SpaceX improvement #8: SpaceX can use Starlink to communicate with Shaded drone in-flight using their new Starlink Block v2.0 satellites that enable low speed internet connections using ordinary 5G phone radios that may add 20 USD in costs to Shaded



Russia has not been able to jam Starlink satellites in Ukraine although they are trying



Also the 5G radio on the Shaded drone can be made directional so only radio signals in direct line between space and the drone are accepted making jamming impossible unless the jammer is located in space and only SpaceX has that with Starlink



Being able to communicate safely with Shaded in-flight in real-time is massively game changing for several reasons:

1.

Shaded will be able to acquire a new target or new flight route if intelligence discover a higher value target or discover active enemy anti-aircraft at flight route

2.

With live intelligence Shaded will be able to hit moving targets like tanks, armored fighting vehicles and trucks

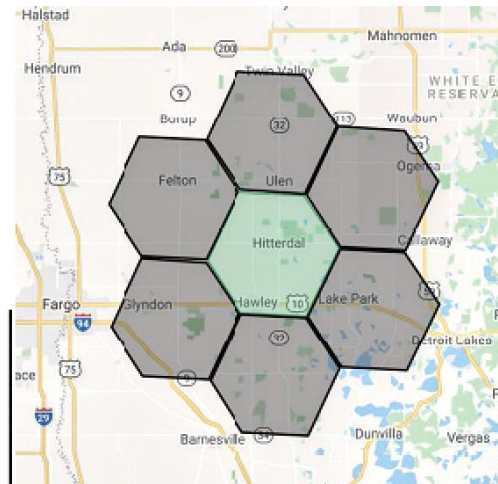
3.

Shaded could be ordered to abort primary target and go for secondary target instead if intelligence discover target is no longer valuable or many civilians are at risk



SpaceX should also make a surveillance Shahed

- ✓ **SpaceX improvement #9:** SpaceX should also make a version that replaces the 45kg warhead with a 35kg warhead + **10kg package of optical and thermal cameras and batteries for surveillance**
- ✓ **Starlink's Gen2 satellites** using 1.4GHz or 5GHz (my source say MHz but that must be an error) channels are capable of 3Mbps or 7.2Mbps peak upload (Earth-to-Space) and up to 4.4Mbps or 18.3Mbps on the downlink (Space-to-Earth)
- ✓ **Communication capacity of Starlink is per hexagon cell** that cover 379 square kilometers. More satellites could have multiple links in each cell covered
- ✓ Starlink connection is fast enough to transfer **high resolution still pictures and low resolution live video**
- ✓ **The surveillance Shahed is expected to cost 1500 USD more than the attack Shahed so 7500 USD**
- ✓ **Note that both the attack and surveillance Shahed can be made reusable if launched with a 500 USD landing gear** that is not ditched after takeoff
- ✓ **Also note that if Shahed fly with a landing gear** its total range will likely drop from 600km to 500km and it operational range if returning to take-off site will be only 250km



- ✓ **SpaceX improvement #10:** The surveillance Shahed should also have the ability to navigate using an uploaded visual map of the landscape along its flight route so it can reach and hit the target in case the GPS is jammed or nuked
- ✓ **Drawback is** that in clouded weather Shahed will have to fly below clouds to see landscape and risk being targeted by anti-aircraft guns



SpaceX should also make a constellation of spy satellites



SpaceX improvement #11: SpaceX is uniquely positioned to build spy satellite network providing high quality intelligence on a massive global scale for target acquisition, flight route planning and target evaluation



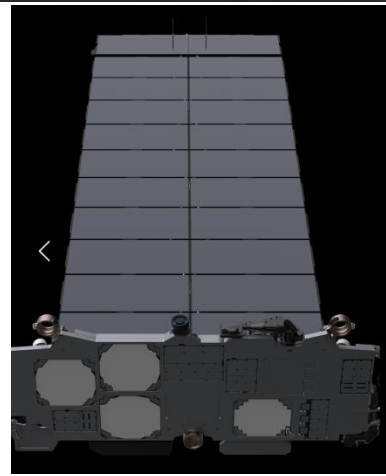
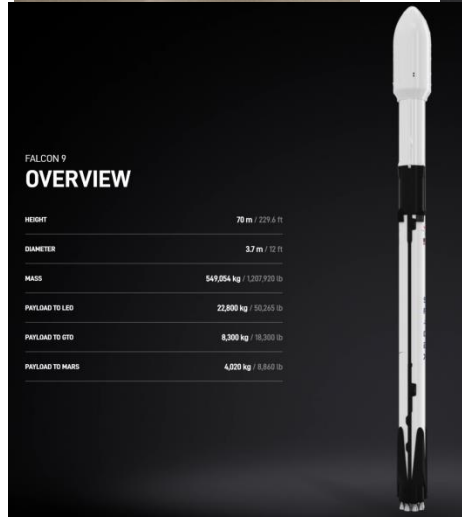
Better intelligence will make Shahed far more effective

Why SpaceX is better positioned than its competition:

1. SpaceX's Falcon 9 rocket is able to launch mass to orbit at **2700 USD per kg versus 7000 to 15,000 USD per kg for everyone else**
2. **SpaceX's Starship** will have its maiden flight to orbit likely in March 2023 and could be operational by end of 2023 for cargo launches
3. Musk say operational goal for Starship is to launch for only 1 million USD or **10 USD per kg to orbit. Fuel is <1M**
4. **SpaceX has developed and mass produced over 3000 satellites** for the Starlink communication network at unit prices that are estimated to be 250k to 500k USD
5. On January 2022 **Earth had 4850 active satellites in orbit**
6. **A quick Google search show a spy satellite is 100 million USD**, a whether satellite is 290 million USD and a non SpaceX communication satellite is about 325 million USD



Musk's First Principles Thinking: If you can mass produce it the cost of raw materials is the limit



Different platform for spy satellites?

✓

Seeing at pictures for the optical spy satellite at the left and the radar (SAR) satellite below it looks like only the radar satellite can be made to fit SpaceX's Starlink Block v2.0 satellites that also fit the dispenser system under development for Starship

1. **This is one reason SpaceX should only focus on making a global network of SAR satellites**
2. SAR sats are also more important because they can **see at night and all kinds of weather**
3. A third reason for SpaceX to do SAR satellites is that **they require massive data processing and have better improvement potential than optical satellites. The harder the better**



Wavelength for radar: 10cm to 0.8cm

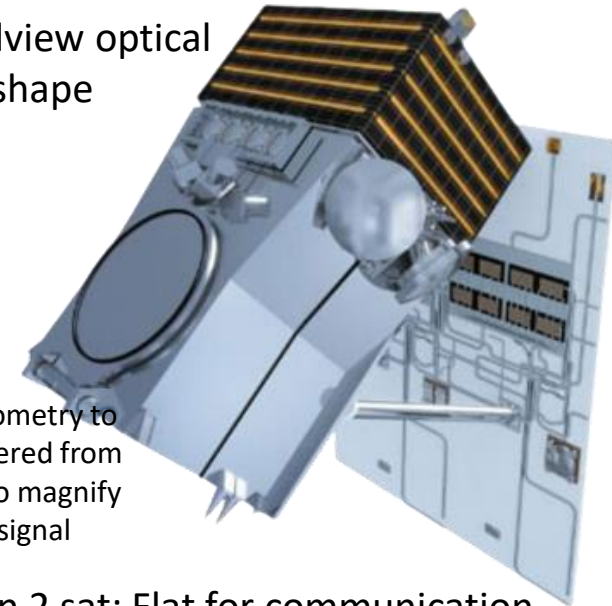
Fact: Resolution is proportional to the size of the numerical aperture and inversely proportional to the wavelength

Synthetic-aperture radar (SAR) spy satellite

MAXAR Worldview optical spy sat: Boxy shape

Wavelength optical light: 550 to 750 nm
so about 100,000 times smaller than radar waves

SAR satellites uses interferometry to combine radar signals gathered from several locations in space to magnify the resolution of the radar signal reflected from earth



SpaceX gen 2 sat: Flat for communication

Wavelength of Starlink Gen2 phone com 1.5GHz to 5GHz:
20 cm to 6cm



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SpaceX should also make the anti-dote

- ✓ It is obvious that with each new war drones become ever more important in numbers and abilities
- ✓ This trend will accelerate because a Shahed drone at 6000 to 7500 USD can be made by any industrialized country even when under economic sanctions
- ✓ **To be sure, Russia is in full swing preparing mass production of Shahed for use against Ukraine**
- ✓ **Huge problem no one have developed a great drone killer** for slow moving <200 km/h inexpensive drones
- ✓ **The best current anti-drone weapons** are anti-aircraft guns with bullets or explosive rounds
- ✓ Anti-aircraft guns can be overwhelmed by swarms of drones attacking simultaneously as their engagement range is about 3 km and that leaves only about 60 seconds to react before the drones hit their targets
- ✓ **SpaceX improvement 12:** Make a much smaller and faster Shahed like drone to kill other drones and infantry but also for intelligence gathering
- ✓ **The triple role to be used both for 1) killing other drones but also for 2) hunting infantry and 3) intelligence is important** because it increases the demand many fold for that drone and thereby makes low cost mass production far more feasible

SpaceX Shahed: Heavy attack drone (35 to 45kg warhead) or long-range (250km to 600km) attack/surveillance drone



SpaceX Shahed mini: Infantry and drone killer (1kg warhead) and short-range (10 to 40km) surveillance drone



SpaceX should also make the anti-dote

Speck sheet for Shahed mini: Drone and infantry killer

- **Weight:** 14 kg instead of 200 kg for ordinary Shahed
- **Keep** delta wing design with propeller at back and 4 control flaps
- **Launch:** Catapult or hand held with pull cable or motor bike (video)
- **Landing:** Retrievable by crash landing in large elastic net
- **Warhead:** 1kg directional shrapnel, 10m radar proximity fuse
- **Spy module:** 2kg optical & thermal camera and active radar homing
- **Speed:** max speed of 350 km/h (see video)
- **Range and duration:** min 40 km flight range and min 45 minutes flight time is good enough for drone and infantry hunting
- **Flight height:** 10 to 4,000 meters
- **Propulsion:** Electric propeller with rechargeable battery, fast charge to 80% in 10 min (preferred over gasoline because design is less complex and operation/storage is less complicated without gasoline)
- **Control modes:**
 1. **“DJI control mode” for infantry hunting and surveillance:** Drone is remote controlled by operator who has video link to **thermal and optical camera** on drone up to 10 km radius from operator
 2. **Starlink control mode for drone killing:** An independent radar station detect incoming enemy drones. A control center calculate trajectory of enemy drones and call up Shahed mini drone operators in that trajectory to launch the Shahed mini drones that are send GPS coordinates via 5G link to Starlink to get within 1 km of enemy drone after which drone is armed and use **active radar homing** to get within 10 meters of enemy drone before it detonates. Range of drone is 40 km and 20 if need to be recovered
 3. **“DJI control mode” for drone killing:** Same method as before but instead of controlling mini Shahed through Starlink it is controlled by the “DJI radio” that is interlinked with control center for Shahed drones. This will limit the range of drone to 10km from take-off



SpaceX Shahed mini (14kg): Infantry and drone killer (1kg warhead) and short-range (10 to 40km) surveillance drone



Sources/attribution for previous slides

- **Image SpaceX constellation:** <https://arstechnica.com/information-technology/2019/10/elon-musk-sends-tweet-via-spacexs-starlink-satellite-broadband/>
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- **Musk has stated that a Starship orbital launch will eventually cost \$1 million (or \$10 per kilogram):** https://en.wikipedia.org/wiki/SpaceX_Starship#:~:text=Musk%20has%20stated%20that%20a,of%20the%20rocket's%20development%20cost.
- **Musk responding to when Starship launch " We have a real shot at late February (2023). March launch attempt appears highly likely.":** <https://twitter.com/elonmusk/status/1611931024514060289>
- **Price of Starlink satellite 250,000 to 500,000 USD each:** <https://www.quora.com/How-much-does-Starlink-cost>
- **On January 2022 there were 4850 active satellites in orbit of which over 3000 was owned by SpaceX:** <https://www.geospatialworld.net/prime/business-and-industry-trends/how-many-satellites-orbiting-earth/#:~:text=According%20to%20UNOOSA%20records%2C%20there,record%20of%20the%20operational%20satellites.>
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- **Image of Synthetic-aperture radar (SAR) spy satellite:** <https://www.iceye.com/press/press-releases>
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- **Great YouTube video about SAR satellites by Scott Manley:** <https://www.youtube.com/watch?v=u2bUKEi9It4>
- **Russia has got blueprint from Iran to make Shahed drone themselves:** <https://edition.cnn.com/2022/11/21/politics/russia-iran-drones-intel-assessment/index.html>
- **Delta wing RC speed 337km/h electric propeller:** <https://www.youtube.com/watch?v=kOPCLts2nSg>
- **Attribution video Delta wing mini drone launch:** <https://www.youtube.com/watch?v=4mXTc5AEbc8>

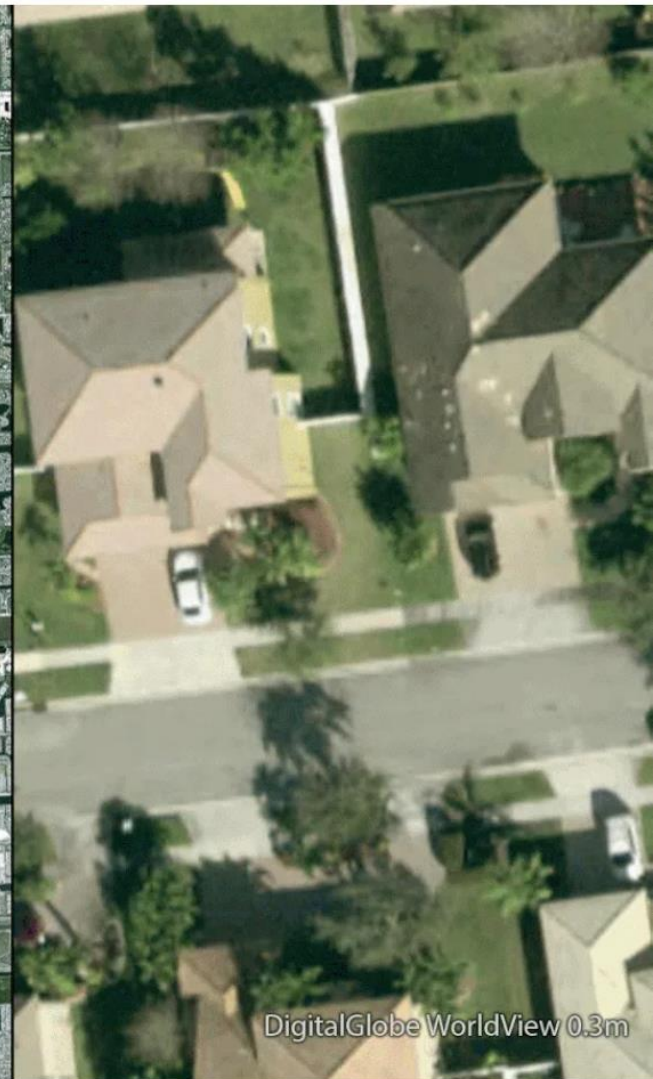


Chapter 5

Target acquisition and evaluation: How much can you see from space?



Optical space pictures different resolutions

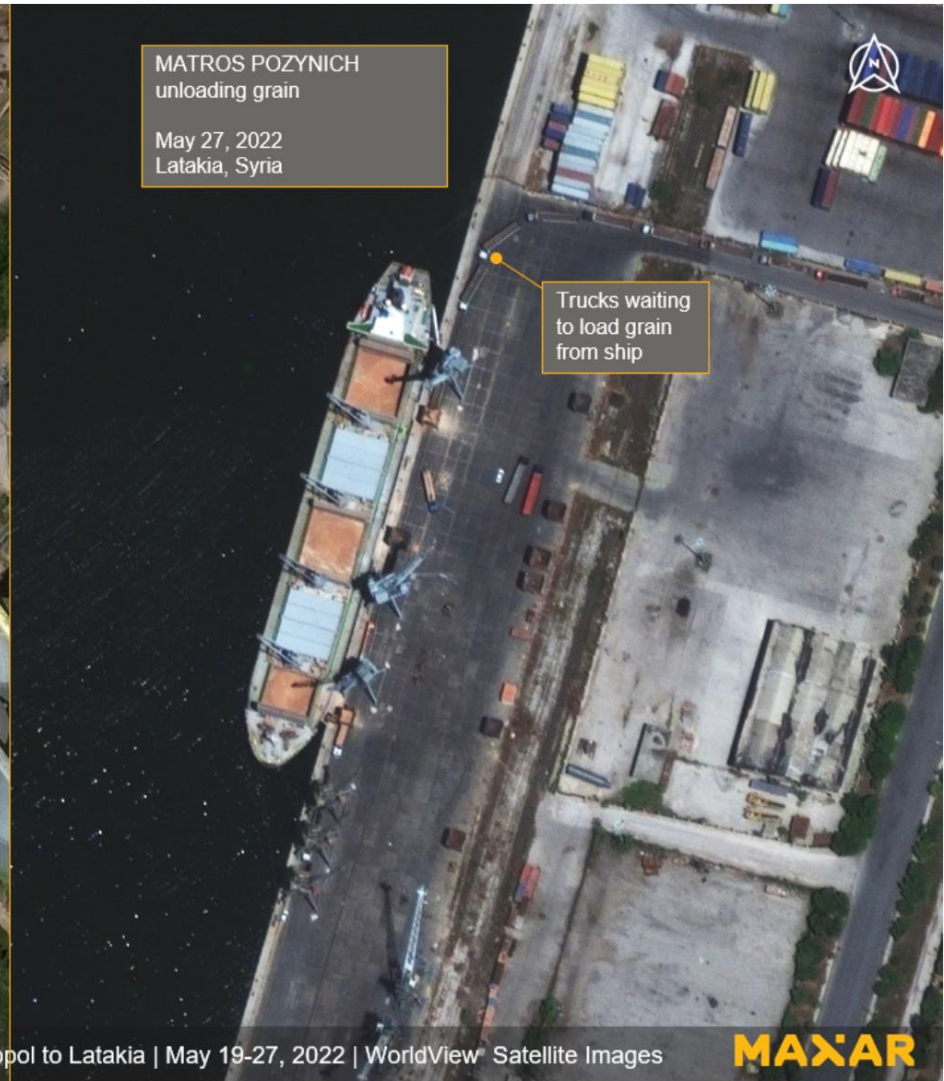
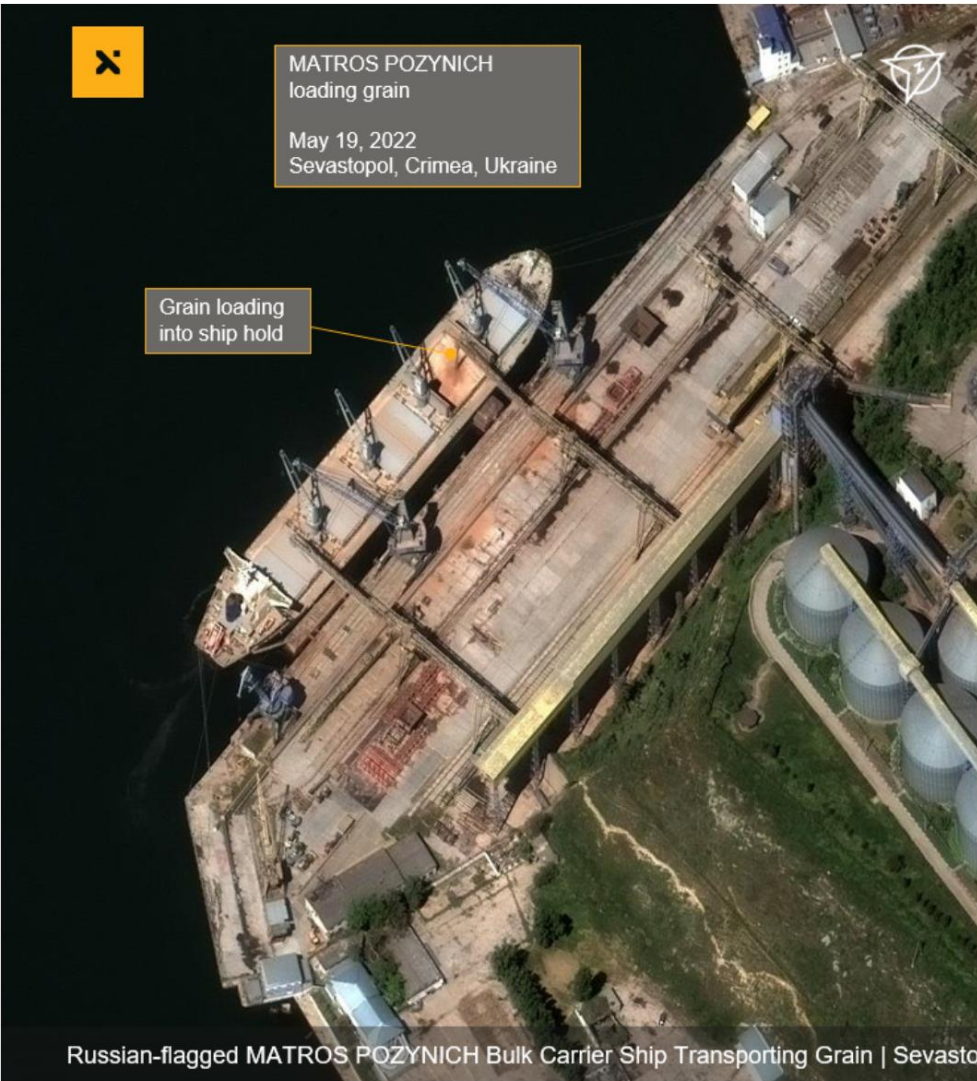


Source: <https://www.nesdis.noaa.gov/news/can-satellites-see-you-can-you-see-satellite>

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Optical space pictures from MAXAR



Russian-flagged MATROS POZYNICH Bulk Carrier Ship Transporting Grain | Sevastopol to Latakia | May 19-27, 2022 | WorldView® Satellite Images

MAXAR



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Optical space pictures from MAXAR



Tanks, self-propelled artillery and armored vehicles are stationed at Opuk training area in Crimea, Ukraine, as seen in this WorldView-3 image from April 15, 2021.

Optical space pictures from MAXAR

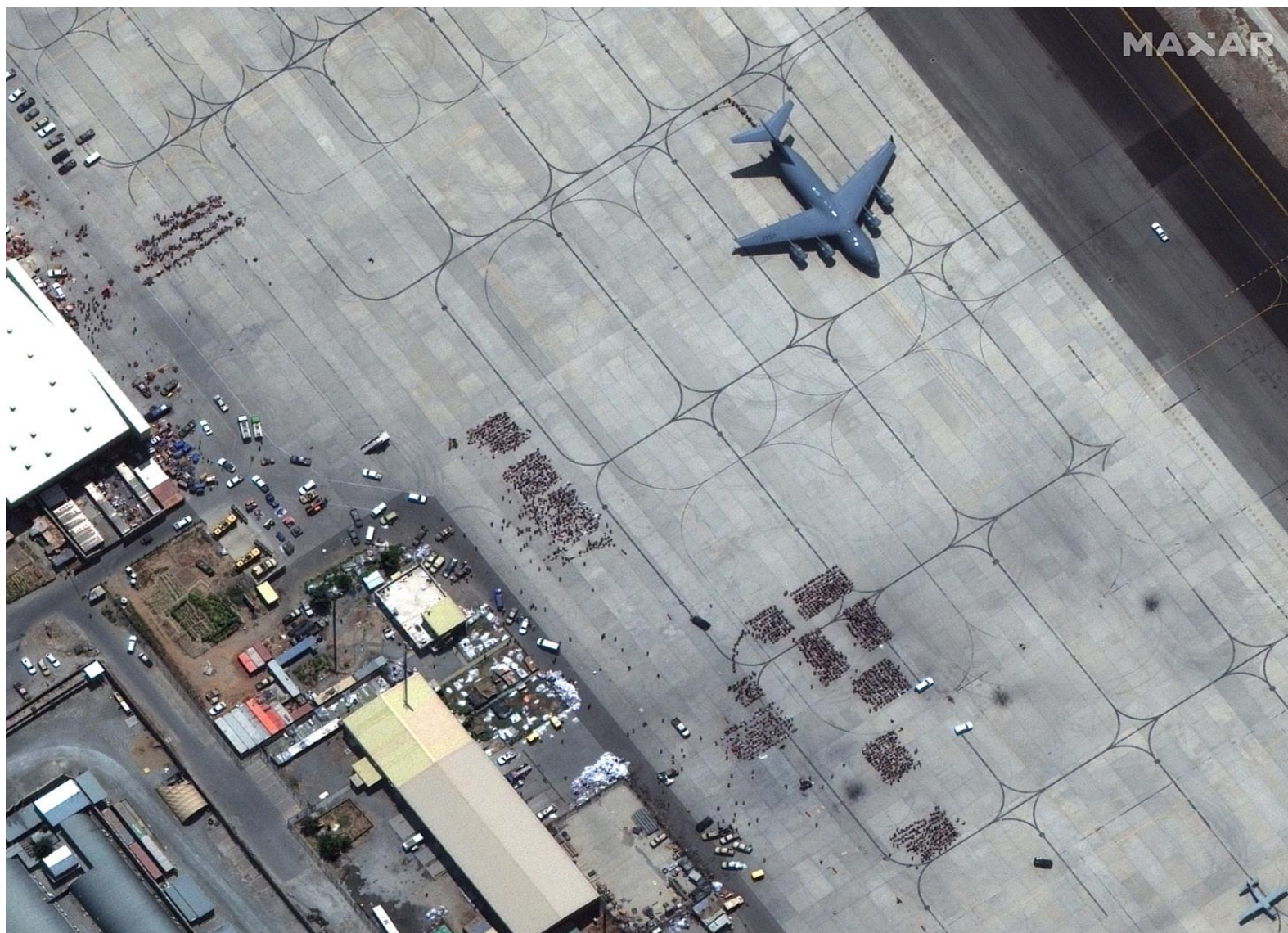


Caption: Russian SU-34 aircraft are parked at Morozovsk Airbase, Russia, on March 27, 2021.

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Optical space pictures from MAXAR



Maxar's WorldView-3 collected this image on August 23, 2021; it shows people organized into several groups waiting to board U.S. military transport aircraft.



Synthetic-aperture radar (SAR) from space 25 cm



ICEYE radar satellite imagery, originally acquired at 25 cm resolution, showing oil tanks in Rotterdam, Netherlands

Source: <https://www.iceye.com/press/press-releases/iceye-unveils-25-cm-sar-imaging-capability-with-current-sar-satellite-constellation>

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Synthetic-aperture radar (SAR) from space 25 cm



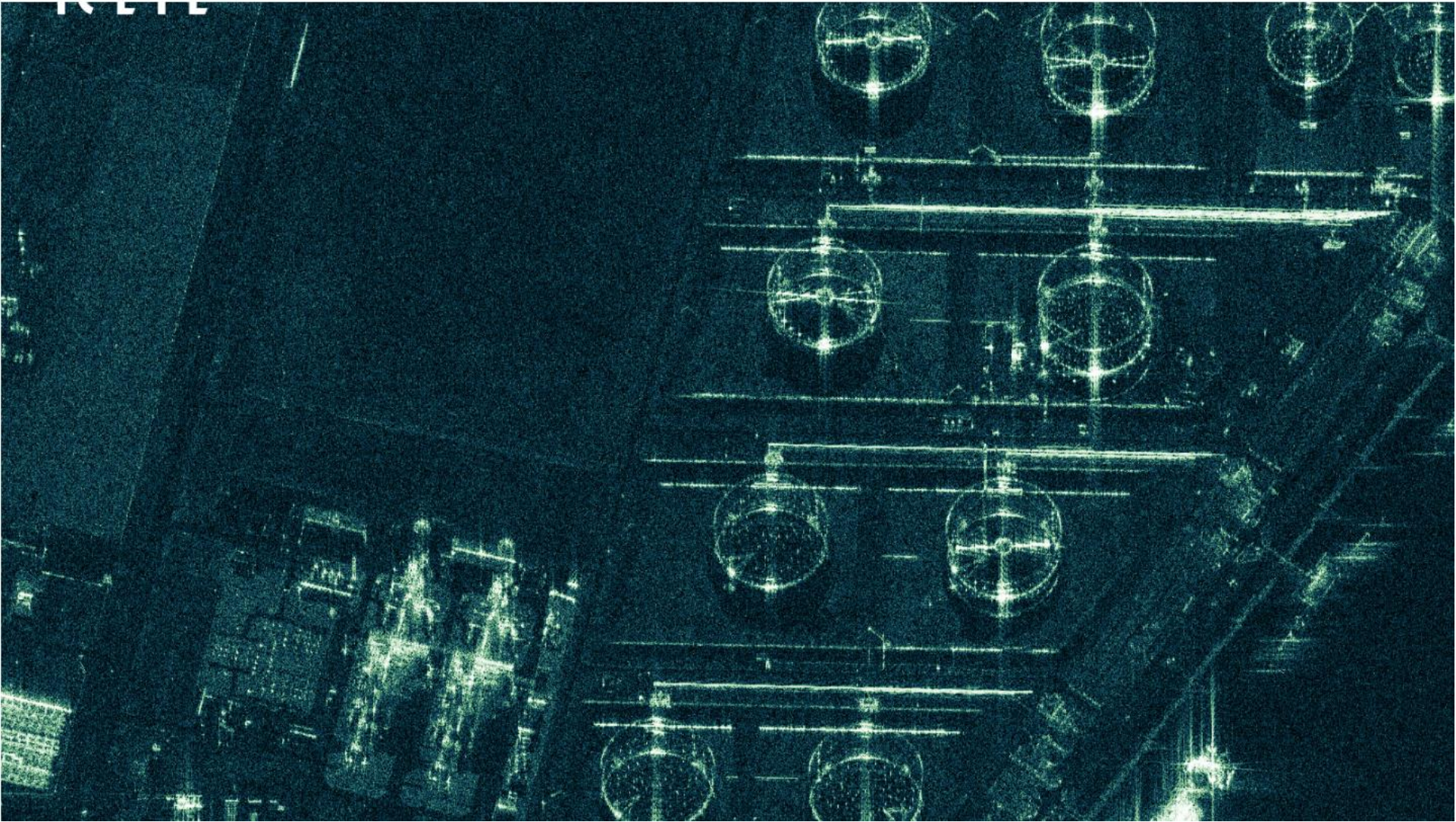
ICEYE radar satellite imagery, originally acquired at 25 cm resolution, showing oil tanks in Rotterdam, Netherlands

Source: <https://www.iceye.com/press/press-releases/iceye-unveils-25-cm-sar-imaging-capability-with-current-sar-satellite-constellation>

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Synthetic-aperture radar (SAR) video from space



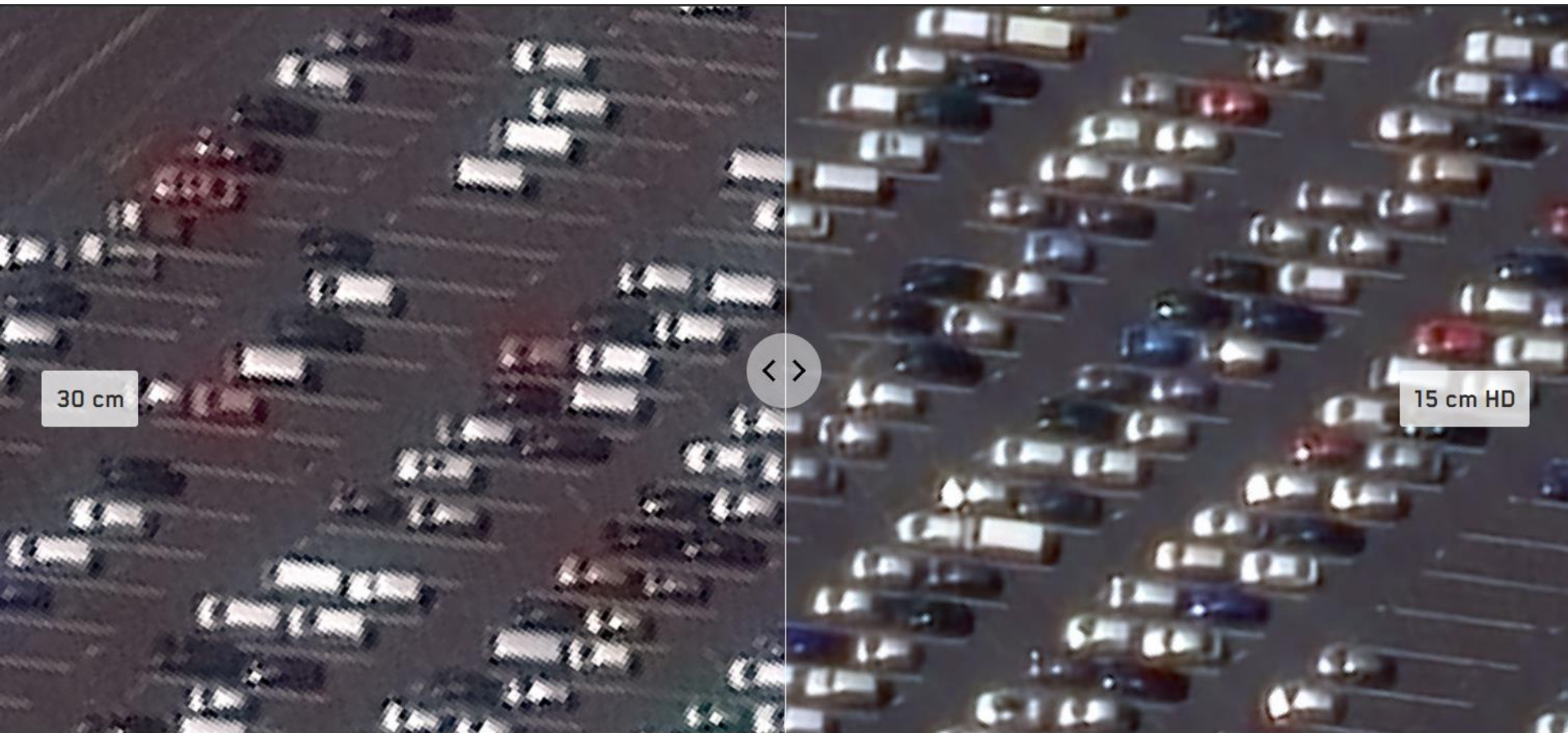
First Look At ICEYE SAR Video [In-Orbit Demo] YouTube channel "ICEYE"

Source: <https://www.youtube.com/watch?v=0Asd7Wq91gM>

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Optical space pictures from MAXAR using AI to improve image resolution



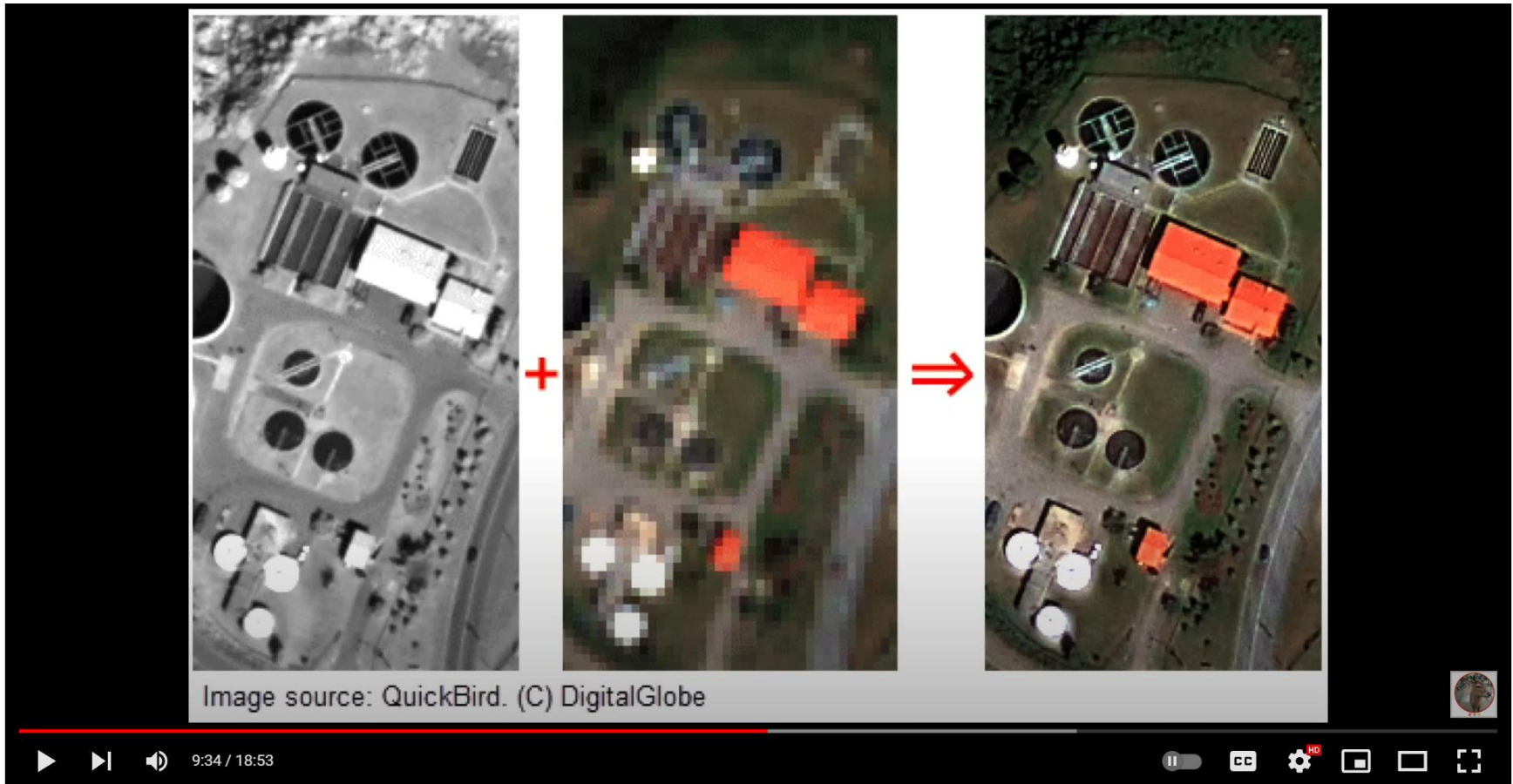
Maxar 30 cm native resolution and AI clean up images to appear as 15 cm resolution:

<https://www.maxar.com/products/optical-imagery#:~:text=Unmatched%20foundational%20data-,Highest%20resolution,making%20through%20improved%20situational%20awareness.>


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Optical space pictures from Quickbird using AI to improve image quality



The Unlimited Possibilities of AI and Satellite Imagery


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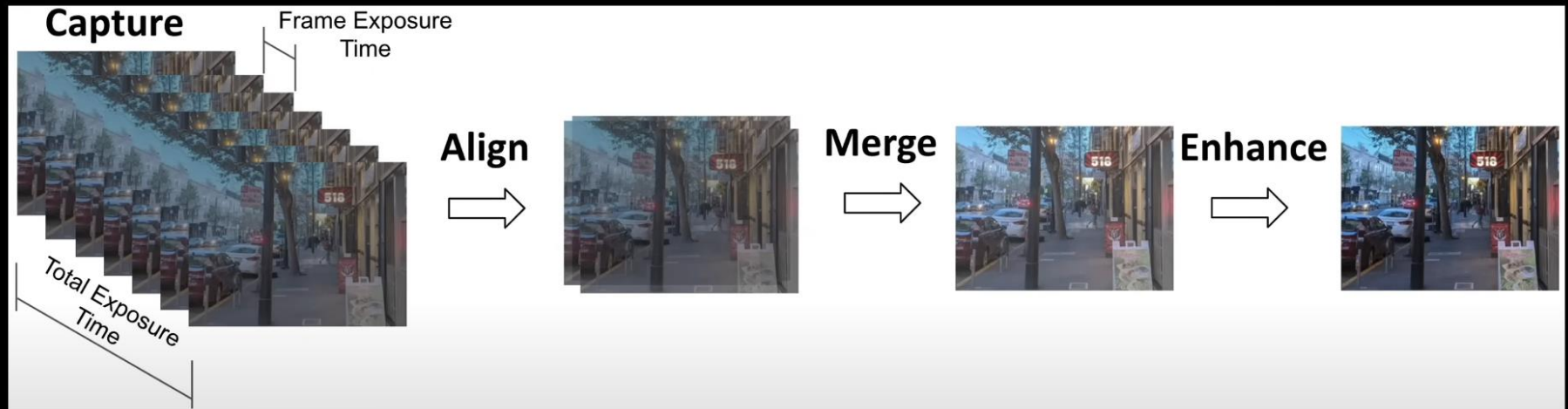
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Using AI to improve image quality



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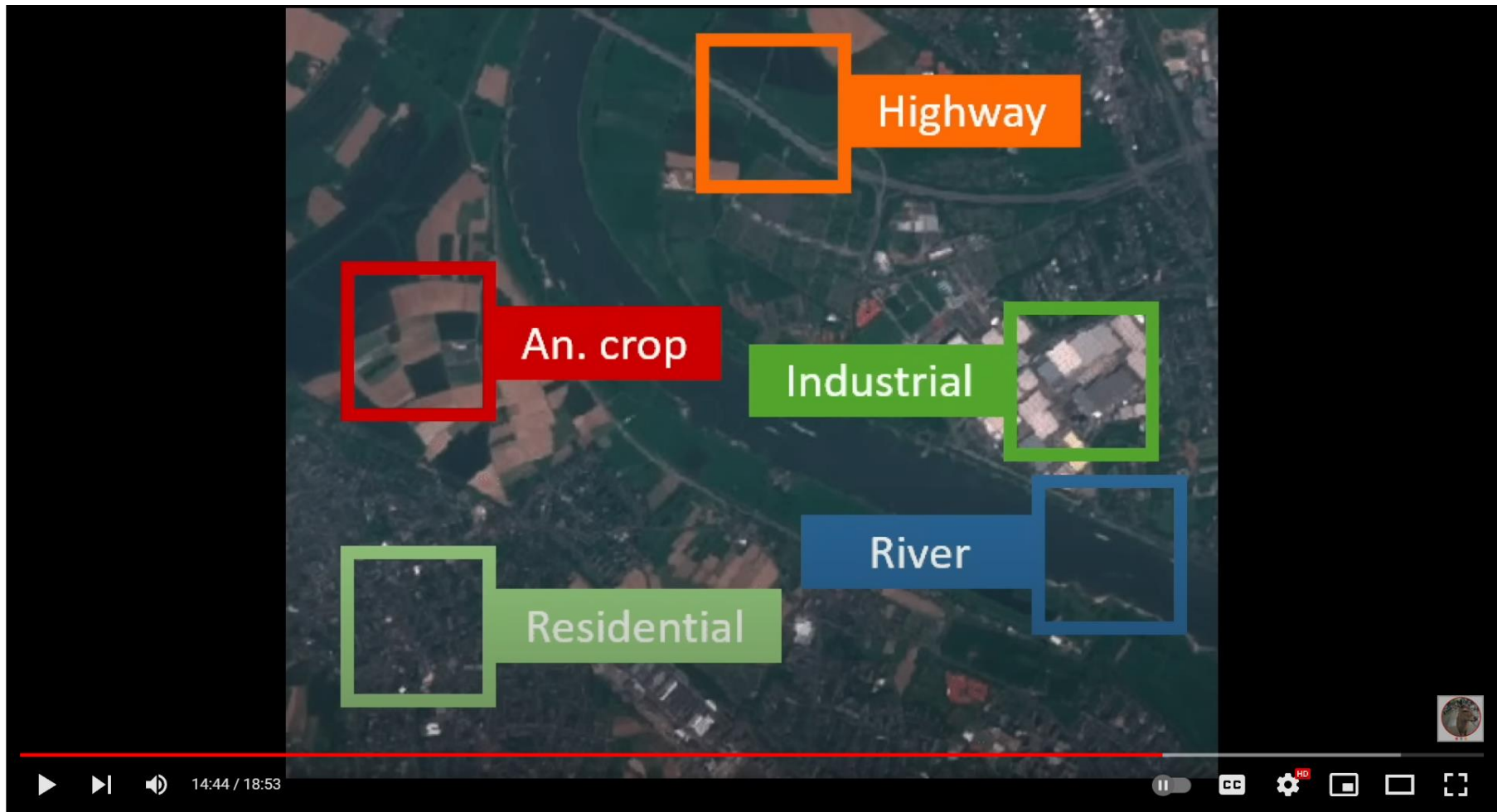
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Using AI to improve image comprehension



The Unlimited Possibilities of AI and Satellite Imagery

Asianometry 430K subscribers Subscribed 3K Share Download Thanks Clip ...



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SpaceX also doing image processing and analysis



SpaceX improvement 13: SpaceX should also do the satellite image data processing and image analysis for the image data gathered by their constellation of spy satellites



The synthetic-aperture radar (SAR) satellite constellation that SpaceX should deploy has the advantage of seeing equally well day and night and in any kind of weather



However, they require much more image processing and analysis than optical images before they can be used



That means big datacenters are needed and also world leading AI development both of which SpaceX's founder and owner Elon Musk is quite familiar with from his work at Tesla



A constellation of thousands of SAR satellites will be able to **know where all aircrafts and ships in the world are on a minutes by minutes basis** (ICEYE ambition is to do so every hour)



It will also be able to **track tanks, heavy artillery, fighting vehicles and trucks that way**



The Unlimited Possibilities of AI and Satellite Imagery
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Sources/attribution for previous slides

- **Maxar 30 cm native resolution and AI clean up images to appear as 15 cm resolution:** <https://www.maxar.com/products/optical-imagery#:~:text=Unmatched%20foundational%20data-,Highest%20resolution,making%20through%20improved%20situational%20awareness.>
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Chapter 6

How inexpensive autonomous drones will revolutionize modern warfare



SpaceX Shaged with autonomous target acquisition

- ✓ **SpaceX improvement #14:** SpaceX's Shaged drones should also have the ability to operate autonomously using AI to identify and prioritize targets for destruction and also to make evasive maneuvers when targeted by anti-aircraft guns
- ✓ **Autonomous target acquisition is not much different technically speaking** than the AI problem of autonomous driving that Tesla is working on solving for land based vehicles
- ✓ **Indeed, autonomous target acquisition** should be a far simpler system to develop and train than autonomous driving because the 3D airspace is not as crowded with hard to predict humans/vehicles/animals as the 2D traffic grid
- ✓ **The exact same computer that Tesla develops** for their vehicles auto-pilot system (currently HW3, <100W) can power SpaceX's Shaged autonomous system (& Teslabot)
- ✓ **In autonomous mode a number of SpaceX Shaheds** could be ordered to 1) systematically scan an enemy sector and if many targets are identified 2) destroy targets prioritized by say first radar, then jamming stations, anti-aircraft, tanks, armored fighting vehicles, trucks, etc
- ✓ **Shaheds not finding a target** will return to base with updated landscape maps and for recharging/refueling for next mission
- ✓ **In autonomous mode the drone will not need any radio communication or even a GPS signal** as they can also navigate looking at maps of the landscape they themselves can make and update autonomously (**such autonomous ability is vital as enemy may otherwise nuke all satellites**)

Tesla autopilot video: Tesla AI software doing environment annotation and making driving decisions in real time



- ✓ **Another kind of autonomous mode for SpaceX's Shaged mini** should be to protect own troops from enemy rockets, drones and even mortar rounds when moving towards enemy positions
- ✓ **Shaged mini could circle own troops** and autonomously react to and target incoming enemy fire (missiles, drones and mortar rounds)
- ✓ **SpaceX improvement #15:** To prevent friendly fire from own drones **troops and drones carry radio beacons that identify them as friendly**

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How else will Shahed mini like drones be used?



Question: How else will war look like in the near future (like 2027) in a world where all armies on Earth have thousands or even millions of Shahed mini on storage?



To be sure, I expect that eventually all infantry men and women will be trained for about one week learning to maintain, launch and control a Shahed mini like drone



Future armies will need to have many times more Shahed mini drones than they got infantry because they will become the primary weapon to kill enemy infantry and also to defend against enemy drone attacks (or >drones than enemy army)



Recall that Shahed mini has much longer range (40km) than anti-aircraft guns (2 to 4km) so they can intercept enemy drones, aircraft, missiles & mortars for much longer time than anti-aircraft guns that has less than 60 seconds to respond to an enemy drone coming in at 185km/h (3km in 60s)



Also thousands of catapult launchers for Shahed mini (see video) can be deployed all over the place say at Ukraine territory. Thousands of anti-aircraft guns are too costly



Whenever a radar pick up an incoming enemy Russian aircraft or missile the Shahed mini could be called up automatically to launch and intercept that threat (recall get within 1 km of aircraft and Shahed is armed and use own radar to home in)



SpaceX improvement #16: Make a portable infantry target "gun" 3kg with thermal zoom that shoot a laser to obtain GPS location on target and a bottom to send 14kg or 200kg Shahed

Launch video for hypothetical SpaceX Shahed mini (14kg): Infantry and drone killer (1kg warhead) and short-range (10 to 40km) surveillance drone



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How else could SpaceX's Shaheds and spy sats be used?

- ✓ Obviously with 10s of thousands of SpaceX radar satellites you will know a lot about the exact position of your enemy's ships, airplanes, tanks, armored fighting vehicles, artillery, radar stations, anti-aircraft guns etc updated globally say every 5 to 10 minutes 24/7
- ✓ SpaceX could sell all this info to subscribing armies for say 10 to 15 billion USD annually (cost the same in peace time and war time)
- ✓ Recall radar/SAR satellites see equally well at night as in daylight
- ✓ They also see through clouds or vegetation so you cannot hide say a tank under some large trees
- ✓ You can hide military assets in warehouses but those can also be identified using AI to see which buildings have military vehicles moving in and out of them and estimate how many
- ✓ All of these targets can be destroyed quickly if you have enough Shahed drones to launch and enough launchers to enable simultaneous attacks that could involve 10s of thousands of drones
- ✓ If you do not have enough human operators to feed drones with target coordinates the drones can be launched in autonomous attack mode over enemy controlled territory
- ✓ 7.5 billion USD will get you 1 million of the most versatile 200kg attack/surveillance Shahed or 2 million of the Shahed mini (7.5B is 1.5 month of Western aid for Ukraine, 722B is ANN US mil. spending)
- ✓ For perspective, remaining Russian army assets in Ukraine could likely be taken out by less than 150k of the 200kg Shaheds and 500k of the mini Shahed to also end all Russian infantry in Ukraine
- ✓ The war could be over as fast as you can make and launch drones
- ✓ Russia has no effective defense against that nor do Ukraine

Russia's losses

09.02.2023

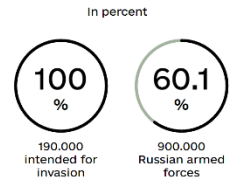
Approximate assessment of the Armed Forces of Ukraine
24.02.2022

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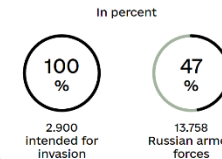
Personnel

~541.040 ⁺³⁶⁴⁰

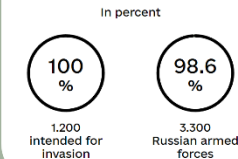
killed ~135.010
wounded ~405.030
prisoner of war ~1.000



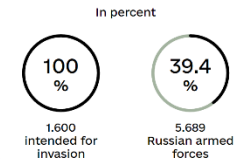
Armored combat vehicles
6468 ⁺¹⁰



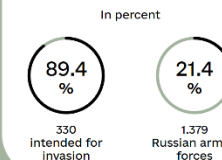
Tanks
3255 ⁺²



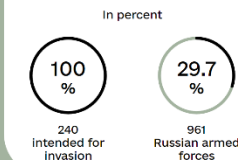
Artillery
2244 ⁺⁸



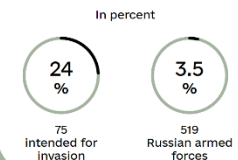
Aircrafts
295



Helicopters
285



Ships and boats
18



Will armored fighting vehicles be needed?



Will armored fighting vehicles be needed in a future with plenty of autonomous Shahed like drones?



Yes, but their primary weapon should be an anti-aircraft gun with exploding rounds like the BAE 40mm Naval Gun



Gun mount is 1.9m high, 2.5tons so may be too big to fit on top of a standard Bradley (2.9m) so redesign may be needed (Bradley with 40mm gun will be 3.7m high)



That gun can shoot down incoming drones (5km), missiles (2.5km) and even mortar rounds and hit stationary or slow moving targets like a truck or mortar position <10km away



A control Bradley could be mounted with powerful 25km radar



Ukraine war has shown that tanks and infantry vehicles are easy kills for anti-tank missiles so equipping **armored fighting vehicles with powerful radar controlled anti-aircraft guns** is a large part of the solution to that problem



Gun can also be used against infantry (will require programmable shell fuse with accurate timer)

Bradley Armored Fighting Vehicle: 25mm machine gun and 2 TOW anti-tank missiles 3.75km



BAE Systems - 40Mk4 Naval Gun: Range 10km slow moving targets (like tank or boat) and 2.5km for missiles



Cutaway of the 40mm 3P shell. The sophisticated fuse and sensors are in the nose. Note the 1,100 pre-fragmented tungsten pellets that surround the 120g PBX charge. When detonated, these are sprayed outward in a lethal cloud of metal that can destroy the delicate systems of missiles or aircraft or take out small boats and personnel. (Image: BAE Systems).

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Will tanks be needed?

- ✓ **Will tanks be needed in a future with plenty of autonomous Shahed like drones?**
- ✓ **YES, but far less will be needed perhaps only 30% of what we used to think we needed on the battlefield**
- ✓ **Note that the role of a tank is to be the biggest gun on the battlefield in close combat**
- ✓ **To a large extent a Shahed with a 35 to 45kg warhead of which most (like 90%) are explosives can overtake that role of the tank**
- ✓ **A 120mm tank shell is typically only 20 kg of which less than half are explosives**
- ✓ **Infantry should be able to call in an attack by a 200kg Shahed that could be launched from 6 km behind enemy lines and arrive at target 3-4 minutes after being requested (or 2 min if already in air)**
- ✓ **Shahed at 185km/h flies 3km in 60 seconds**
- ✓ **Only two advantages of tank is that 1) its shells can not be stopped by anti-aircraft guns or drones, 2) it may be faster to shoot a target requested by infantry**
- ✓ **But tanks are easily destroyed by anti-tank missiles or 200kg Shahed drones**
- ✓ **Therefore, in future drone wars tanks need to be protected by 1) armored fighting vehicles with powerful anti-aircraft guns as well as 2) swarms of mini-Shahed drones**

Leopard II battle tank



The M1A2 TUSK Abrams Tank



Will 155mm artillery be needed?

- ✓ **Will 155mm artillery be needed in a future with plenty of autonomous Shahed like drones?**
- ✓ **My expectation is that 155mm artillery can be fully replaced** by an abundance of 200kg Shahed drones. **The reasons are:**
 1. **Costs:** You need to fire about 100 shells costing 1000 USD a piece before you hit your target or spend 100,000 USD to destroy a target. Shahed can do it for 7500 USD or 3X that i.e. 22.500 USD to account for losses
 - But enemy also spend resources shooting down Shaheds
 2. **Time to fire:** It requires more time, people and equipment to fire 100, 155mm shells rather than launch 3 Shaheds
 - Note the 200kg SpaceX Shahed can be launched on a paved road using a landing gear where they can be lined up and ready to go by pushing a button
 3. **Detection of fire location:** The exact location of firing for conventional artillery is easily detected by enemy radar the second you fire so they can launch counter (drone) attracts on that location
 - The launch of Shaheds can avoid detection by flying under the radar but can still be detected if enemy use airborne radar or radar satellites
 4. **Simultaneous 360° attacks:** The Shaheds can be programmed to hit their targets simultaneously from all angles unlike conventional artillery that hit targets sequentially and therefore the first round is a warning to seek shelter immediately making subsequent rounds less deadly for enemy
 5. **More destructive:** Shahed has 35 to 45kg warhead of which most is TNT v. standard 155mm shell that weights 43kg and has 7kg of TNT
 6. **Range:** 155mm shell max 40km for standard shell 70km for Excalibur shell costing min 30,000 USD. Shahed 600 km
 7. **Reusability:** Artillery cant be reused. Shahed can abort mission and land if launched with landing gear attached and reused for another day

An ARCHER 155mm Artillery System



M777 howitzer, 155mm



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Chapter 7

Why SpaceX should also make drone weapons and spy satellites



Why should SpaceX do this?

Why? Two reasons:

1. **Most importantly the good guys in the world need the best weapons** or the future of all of humanity will be life under tyranny rather than life in freedom
2. **It is good business** and Musk needs the profits to fund his mission for developing a sustainable civilization on Mars
 - Musk has been ridiculed for having that mission as of late by B. Gates and that is very wrong IMO
 - Colonizing Mars is a necessary condition but not sufficient for preserving sentient life in the universe (we are still the only evidence sentient life exist in observable universe)

Why not let other companies make spy satellites and drones?

1. **SpaceX can make more money** doing this themselves
2. **SpaceX already have the scale and resources** to make this happen quickly. They have launch system and much of the needed expertise
3. **The expertise SpaceX currently lack** they can get from Tesla and perhaps also by acquiring the Finish company ICEYE (for obtaining SAR/satellite radar expertise)



Why should SpaceX do this?

Why should SpaceX do it not Tesla?

1. **Because Musk owns about 50% of SpaceX** but only 15% of Tesla so he will make more money doing it in SpaceX
2. **Also SpaceX makes things that flies** Tesla do not
3. **SpaceX is already a supplier for the US military** and has procedures and clearances in place to make top secret stuff
4. **SpaceX should make autonomous drones because they can still sell these drones and prevent bankruptcy of SpaceX** in case Russia go rouge and decide to nuke all satellites out of space
 - **Why on earth would Russia nuke space** and also make an enemy out of China and India that will also have their satellites destroyed by Russia if they nuke space?
 - **Because Ukraine may in 2024 overwhelm the Russian army** by attacking it with an abundance of cheap, non-autonomous drones that need GPS to function
 - **However, if Ukraine in 2024 instead can attack Russian army with an abundance of autonomous drones** then Russia gain almost nothing and lose a lot by nuking space as these drones will function regardless
 - **IMO SpaceX is the only company in the world** that can bring fully autonomous Shahed like drones to market in volume by 2024 and thereby decrease the risk of Russia nuking space
 - **If SpaceX do not do this** the only drones Ukraine can get in volume by 2024 will be the non-autonomous drones that any industrialized nation can mass produce and that Russia can ground if they nuke space



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Chapter 8

Concluding remarks

