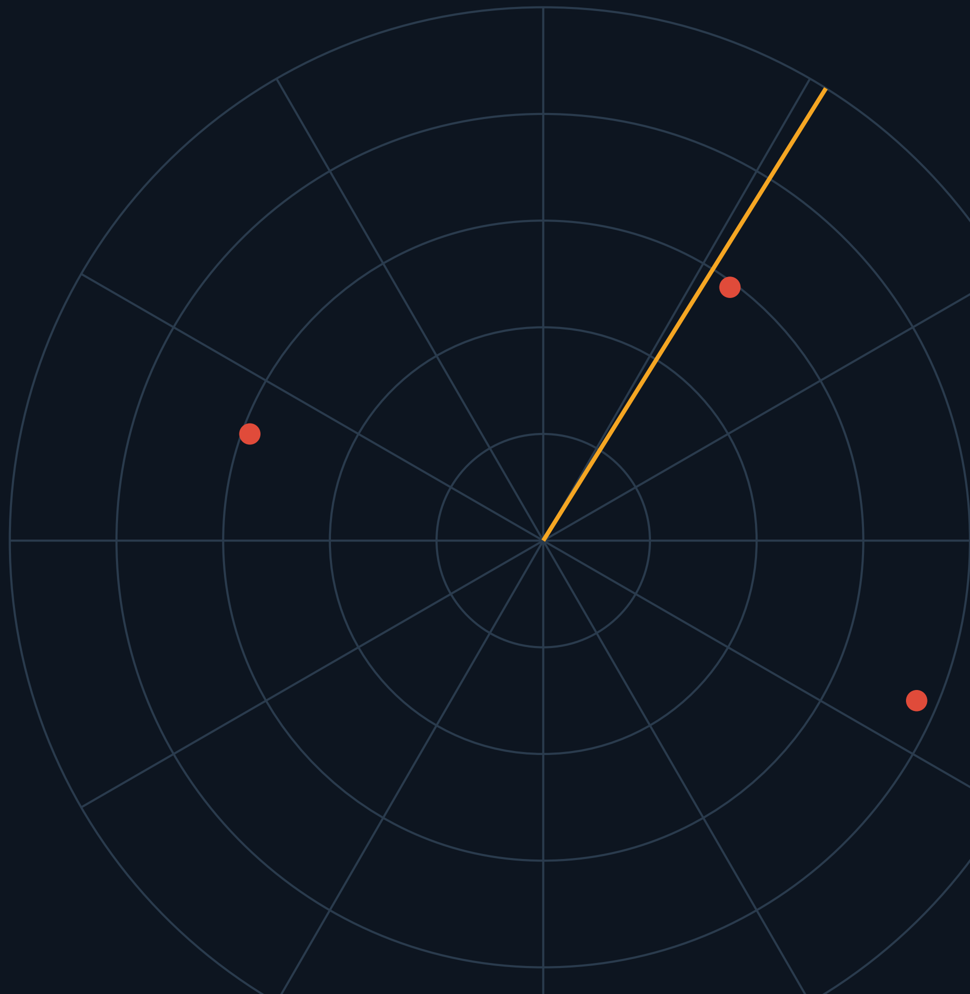
ANALYZING RUSSIA'S MOST ADVANCED MISSILE SYSTEMS

Capabilities and Strategic Implications

A comparative open-source assessment of five key systems:

- **P-800 Oniks**
- **3M22 Zircon**
- **Iskander-M**
- **Kh-47M2 Kinzhal**
- **Oreshnik**

SCOPE: Speed · Range · Warhead capacity · Kinetic impact · Flight profiles · Defensive implications. All figures derived from open, publicly available sources; ranges reflect the spread of published estimates.



IDEO-LAB · ANALYTICAL BRIEFING · JULY 2026

EXECUTIVE SUMMARY

In the evolving landscape of modern warfare, Russia's hypersonic and ballistic missile arsenal continues to attract significant attention from defense analysts and policymakers. This briefing compares five key systems — **P-800 Oniks**, **3M22 Zircon**, **Iskander-M**, **Kh-47M2 Kinzhal**, and **Oreshnik** — across speed, warhead capacity, kinetic impact, and overall destructive potential.

Three headline findings emerge. **First**, the Oreshnik and Kinzhal represent the current pinnacle in speed and destructive reach. **Second**, the Zircon excels specifically in naval-denial roles, where its scramjet-sustained hypersonic cruise and plasma effects complicate radar tracking. **Third**, the mature Iskander-M remains the workhorse: precise, flexible, and battle-proven at scale.

WHY IT MATTERS

Hypersonic speed compresses defender reaction time from tens of minutes to single digits. Maneuverability defeats trajectory prediction. Together, they stress every layer of existing air and missile defense architectures — sensors, interceptors, and command-and-control alike.

THE FIVE SYSTEMS AT A GLANCE

P-800 Oniks	Supersonic anti-ship / land-attack cruise missile. The reliable veteran.
3M22 Zircon	Scramjet hypersonic cruise missile. The ship-killer of the 2020s.
Iskander-M	Quasi-ballistic SRBM. Surgical precision, conventional or nuclear.
Kh-47M2 Kinzhal	Air-launched aeroballistic missile. Speed married to reach.
Oreshnik	MIRV-capable IRBM. Saturation by kinetic penetrators.

CONTENTS

01	Cover
02	Executive Summary
03	Contents
04	Master Comparison Table
05	Two Decades of Evolution (Timeline)
06	System Silhouettes
07–08	**P-800 Oniks — Profile & Technical Cutaway**
09–10	**3M22 Zircon — Profile & Technical Cutaway**
11–12	**Iskander-M — Profile & Technical Cutaway**
13–14	**Kh-47M2 Kinzhal — Profile & Technical Cutaway**
15–16	**Oreshnik — Profile & Technical Cutaway**
17	Speed — The Hypersonic Divide
18	Range — From Tactical to Continental
19	Warheads & Kinetic Impact
20	Flight Profiles — Five Ways to Arrive
21	The Defender's Clock
22	**Propulsion Technologies Deep Dive**
23	**Guidance & Precision Deep Dive**
24	**Anatomy of a MIRV Strike**
25	**The Radar Horizon Problem**
26	**Layered Defense vs Flight Bands**
27	**Cost-Exchange Economics**
28	**Launch Platforms**
29	Strategic Assessment
30	Implications for Global Defense Postures
31	Glossary, Methodology & Caveats

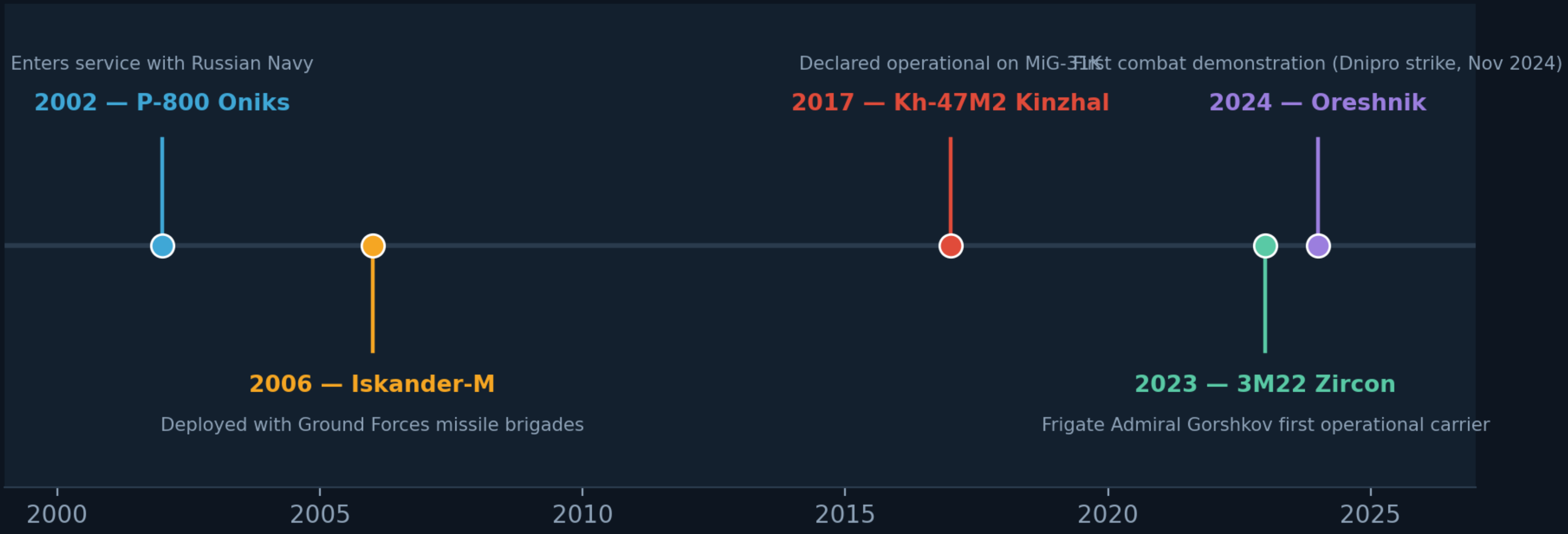
Part I: Systems (p. 4–16) · Part II: Comparative Analysis (p. 17–21) · Part III: Technology Deep Dives (p. 22–28) · Part IV: Strategy (p. 29–31)

MASTER COMPARISON TABLE

SYSTEM	CLASS	SPEED	RANGE	WARHEAD	PRECISION (CEP)	LAUNCH PLATFORM
P-800 Oniks	Supersonic cruise missile	Mach 2–2.6	300–800 km	200–300 kg HE / semi-armor-piercing	≈1.5–25 m (active radar seeker)	Ships, subs, Bastion coastal
3M22 Zircon	Hypersonic cruise (scramjet)	Mach 8–9	600–1,000 km	≈300–400 kg	Est. 10–20 m	Frigates, subs (3S-14 VLS)
Iskander-M	Quasi-ballistic SRBM	Mach 6–7	400–500 km (extended reported)	480–700 kg (conv. or nuclear)	5–30 m (optical/GLONASS)	Road-mobile TEL (9P78-1)
Kh-47M2 Kinzhal	Air-launched aeroballistic	Up to Mach 10	460–2,000 km (with carrier radius)	≈480–500 kg (conv. or nuclear)	Est. 10–20 m	MiG-31K, Tu-22M3 (rep.)
Oreshnik	IRBM, MIRV	Mach 10–11	3,500–5,500 km	6 MIRV × submunitions (kinetic penetrators)	Est. <100 m (per RV)	Road-mobile TEL (RS-26 derived)

READING NOTE: Figures are open-source estimates and vary between publications; ranges shown capture the credible spread. Speeds are peak values — terminal velocity is typically lower due to atmospheric drag, especially for aeroballistic and ballistic profiles. CEP = Circular Error Probable, the radius within which 50% of rounds are expected to land.

SERVICE ENTRY TIMELINE



THE TRAJECTORY OF A DOCTRINE. The timeline tells a story of deliberate escalation in capability. The **Oniks** (2002) belongs to the late-Soviet school: fast, robust, sea-skimming. The **Iskander-M** (2006) introduced maneuvering quasi-ballistic flight to frustrate Patriot-class interceptors. The **Kinzhal** (2017) put a ballistic missile under an aircraft, adding hundreds of kilometers of carrier radius and unpredictable launch axes. The **Zircon** (2023) achieved what had long been theoretical: sustained scramjet-powered hypersonic cruise from a standard naval launch cell. And the **Oreshnik** (2024) — first demonstrated in combat against Dnipro in November 2024 — brought MIRV technology, once reserved for intercontinental systems, into the regional (intermediate-range) strike domain. Each step compresses defender decision time and multiplies the interception problem.

SYSTEM SILHOUETTES

SYSTEM SILHOUETTES (stylized, not to scale)

P-800 Oniks

L 8.9 m · Ø 0.7 m · 3,000 kg

Ramjet · sea-skimming profile

3M22 Zircon

L ≈8–9 m · est. 4–5 t

Scramjet · hypersonic glide-cruise

Iskander-M

L 7.3 m · Ø 0.92 m · 3,800 kg

Single-stage solid · quasi-ballistic

Kh-47M2 Kinzhal

L ≈7.7 m · ≈4,300 kg

Air-launched (MiG-31K) · aeroballistic

Oreshnik

IRBM · est. 2 stages, solid fuel

MIRV bus · 6 RVs × submunitions

DESIGN LANGUAGES

Ramjet cruise (Oniks): ventral intake, cruciform fins, blunt ogive — optimized for Mach 2+ at very low altitude.

Scramjet (Zircon): flattened sharp nose and booster stage; the airframe itself generates compression at Mach 8+.

Quasi-ballistic (Iskander-M): thick single-stage body, gas-dynamic + aerodynamic controls for whole-trajectory maneuvering.

Aeroballistic (Kinzhal): an Iskander-family airframe adapted for air launch at speed and altitude.

IRBM (Oreshnik): two solid stages topped by a MIRV bus.

P-800 ONIKS · SS-N-26 STROBILE

ANTI-SHIP · LAND-ATTACK · SUPERSONIC · SEA-SKIMMING

The Oniks is the seasoned professional of this lineup. Developed by NPO Mashinostroyeniya and in service since 2002, it flies a high-low profile: cruising at altitude to conserve fuel, then dropping to a wave-hugging 10–15 meters for the terminal run, where sea clutter and the radar horizon shrink a defender's engagement window to seconds. Its 200–300 kg semi-armor-piercing warhead, delivered at Mach 2+, is designed to penetrate a warship's hull before detonating. It is less exotic than its hypersonic siblings — but reliable, mass-produced, and repeatedly used against land targets in Ukraine, where its speed still makes it a difficult intercept for medium-range systems.

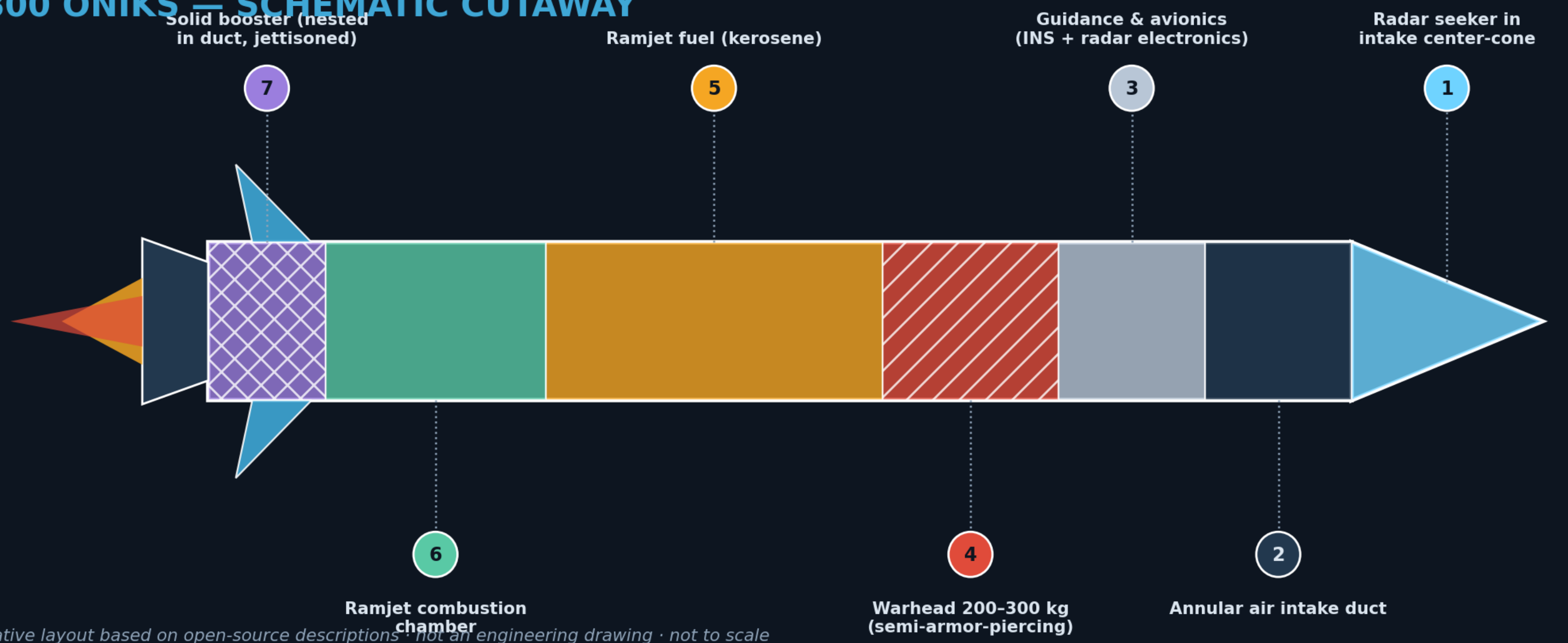
Qualitative profile (1–10, open-source assessment)

Class	Supersonic cruise missile
Speed	Mach 2–2.6
Range	300–800 km (variant-dependent)
Warhead	200–300 kg HE / semi-armor-piercing
Propulsion	Solid booster + liquid-fuel ramjet
Guidance	Inertial + active/passive radar seeker
Platforms	Surface ships, submarines, Bastion-P coastal batteries

DID YOU KNOW? The export version, the **Yakhont**, and the joint Russian-Indian **BrahMos** share the same lineage — making the Oniks family one of the most widely proliferated supersonic anti-ship designs in the world.

P-800 ONIKS — TECHNICAL CUTAWAY

P-800 ONIKS — SCHEMATIC CUTAWAY



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SENSORS / SEEKER · GUIDANCE & AVIONICS · WARHEAD / PAYLOAD · FUEL · ENGINE / SUSTAINER · BOOSTER / STAGES

1	Radar seeker in intake center-cone	Active/passive radar homing head packaged inside the shock cone of the nose air intake — a hallmark of Soviet ramjet design.
2	Annular air intake duct	Ram air flows around the central body to feed the engine; the duct doubles as structure.
3	Guidance & avionics	Inertial platform plus radar electronics; supports 'wolf-pack' salvo logic where missiles reportedly share targeting.
4	Warhead (200–300 kg SAP)	Semi-armor-piercing: delayed fuze lets the missile punch through a hull before detonating inside.

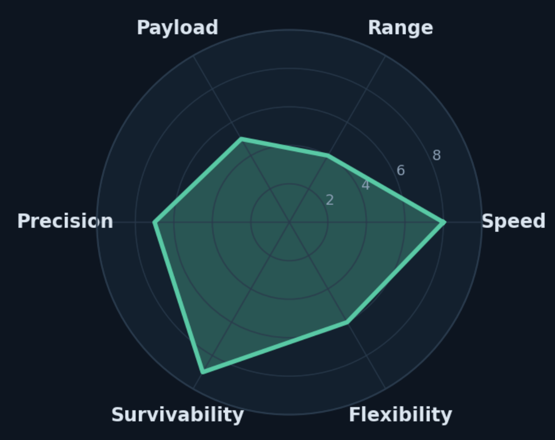
5	Ramjet fuel	Kerosene feeding the sustainer during cruise; the high-low flight profile trades fuel for terminal stealth.
6	Ramjet combustion chamber	Subsonic-combustion ramjet sustains Mach 2+ after boost.
7	Nested solid booster	Launch booster sits inside the ramjet duct and is ejected once the ramjet takes over — saving length and weight.

Schematic representation for educational purposes, compiled from open-source descriptions — not an engineering drawing; proportions and internal arrangement are illustrative.

3M22 ZIRCON · SS-N-33

HYPERSONIC | SCRAMJET | NAVAL DENIAL | PLASMA EFFECTS

The Zircon is the system that turned a decades-old aerospace ambition — sustained scramjet-powered hypersonic cruise — into a deployed naval weapon. Flying at Mach 8–9 in the upper stratosphere, it compresses a 500 km engagement to under three minutes. At these speeds the airframe is sheathed in ionized plasma, which absorbs and distorts radar returns, complicating both detection and terminal-phase tracking. Its kinetic energy alone at impact rivals the explosive yield of its warhead: a multi-ton object arriving at ~2 km/s delivers devastating structural damage to large surface combatants. First combat-tested against land targets in Ukraine in early 2024, its primary design role remains carrier-group denial.

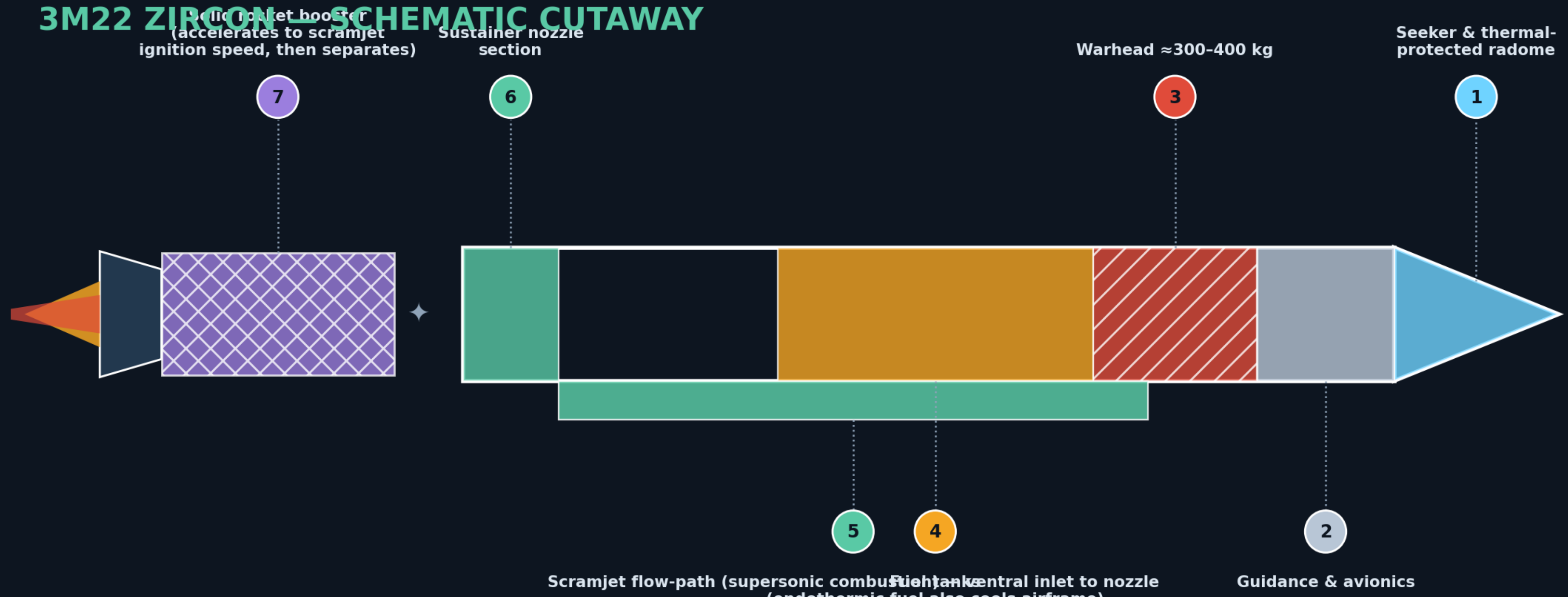


Qualitative profile (1–10, open-source assessment)

Class	Hypersonic cruise missile
Speed	Mach 8–9
Range	600–1,000 km (claims vary)
Warhead	≈300–400 kg
Propulsion	Solid booster + scramjet sustainer
Cruise altitude	≈28–40 km
Platforms	Admiral Gorshkov-class frigates, Yasen-class subs (3S-14 VLS)

DID YOU KNOW? At Mach 9, the Zircon covers one kilometer in roughly a third of a second — a ship's close-in weapon system may have under 10 seconds of engagement time after horizon crossing.

3M22 ZIRCON — TECHNICAL CUTAWAY



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SENSORS / SEEKER · GUIDANCE & AVIONICS · WARHEAD / PAYLOAD · FUEL · ENGINE / SUSTAINER · BOOSTER / STAGES

1	**Thermally protected radome & seeker**	Sensors must see through the plasma sheath; radome materials handle >1,000°C surface temperatures.
2	**Guidance & avionics**	INS/GLONASS midcourse with terminal seeker; details remain among the most classified aspects.
3	**Warhead (≈300–400 kg)**	Moderate mass — at Mach 8+ the kinetic energy contribution rivals the explosive fill.
4	**Fuel tanks**	Reported endothermic fuel absorbs airframe heat before combustion — fuel as coolant, a key hypersonic enabler.

5	**Scramjet flow-path**	Ventral inlet-to-nozzle duct where combustion occurs in supersonic airflow.
6	**Sustainer nozzle section**	Expansion surface integrated into the aft body.
7	**Solid rocket booster**	Separate first stage accelerates the vehicle to scramjet ignition speed (≈Mach 4), then separates.

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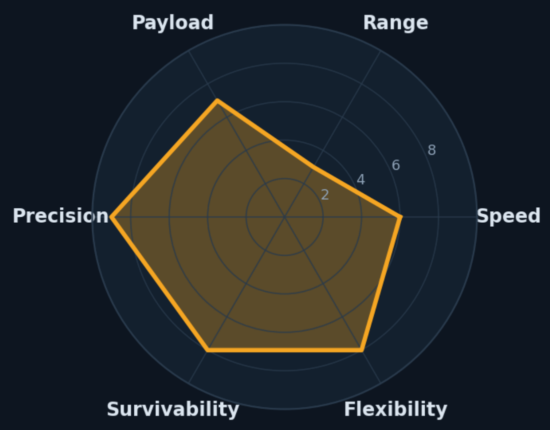
ISKANDER-M · SS-26 STONE

QUASI-BALLISTIC · PRECISION · DUAL-CAPABLE · ROAD-MOBILE

If the hypersonics are the headline acts, the Iskander-M is the workhorse that actually defines Russian deep-strike practice. It never leaves the atmosphere, flying a depressed 'quasi-ballistic' arc while maneuvering with gas-dynamic and aerodynamic controls — denying defenders the predictable ballistic track their fire-control computers prefer. With optical scene-matching terminal guidance, its CEP of 5–30 meters makes it a true precision weapon against hardened, high-value targets: command posts, air-defense radars, airfields, ammunition depots. Its warhead menu — from 480 kg unitary HE to cluster, thermobaric and nuclear options — makes it Russia's most versatile and most heavily used ballistic system, with thousands fired in the Ukraine conflict.

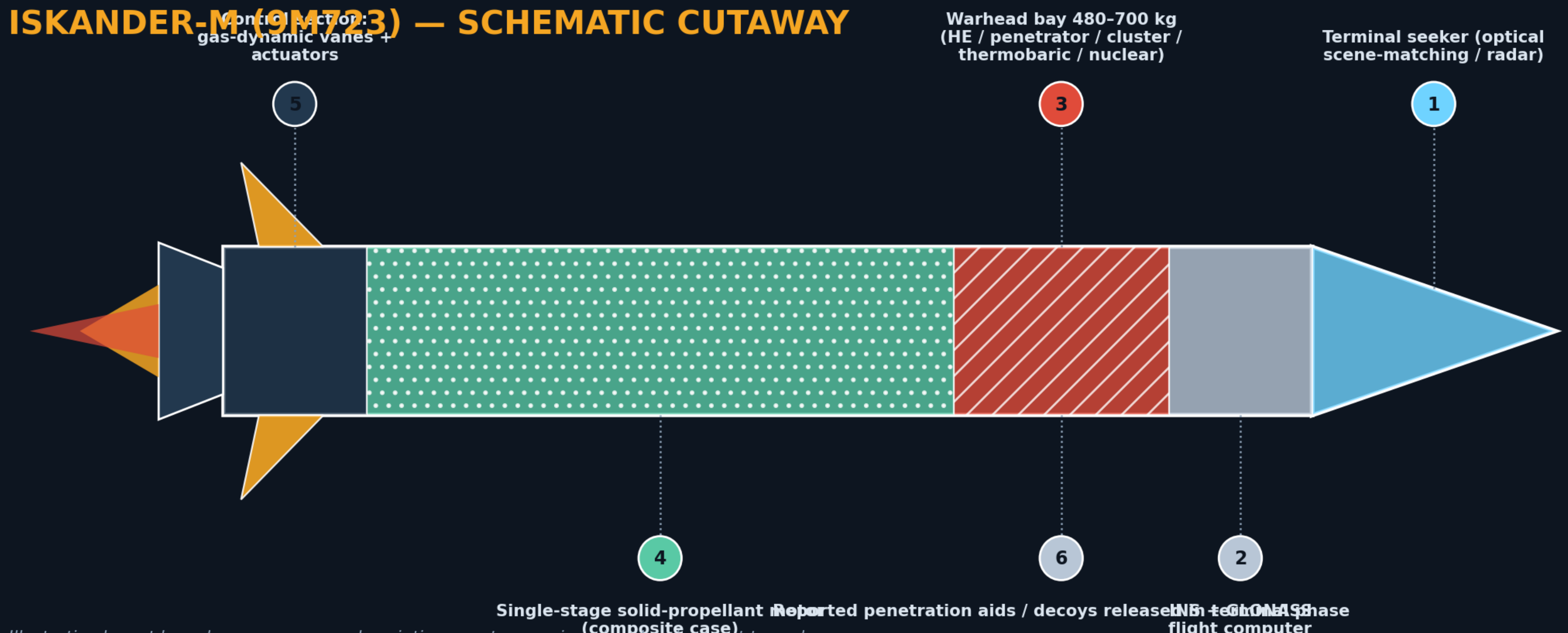


Qualitative profile (1–10, open-source assessment)

Class	Short-range quasi-ballistic missile (SRBM)
Speed	Mach 6–7
Range	400–500 km (extended variants reported)
Warhead	480–700 kg — unitary HE, penetrator, cluster, thermobaric, or nuclear
Precision	CEP 5–30 m (optical terminal guidance + GLONASS)
Flight profile	Depressed trajectory, apogee ≈50 km, maneuvers throughout
Platform	9P78-1 TEL, 2 missiles per vehicle

DID YOU KNOW? The Iskander-M reportedly releases decoys during its terminal phase, and its final maneuvering can pull up to 20–30 g — forces no manned aircraft could survive.

ISKANDER-M — TECHNICAL CUTAWAY



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1	**Terminal seeker**	Optical scene-matching (correlates live imagery with stored target reference) and/or radar seeker depending on variant — the source of its 5–30 m CEP.
2	**INS + GLONASS flight computer**	Manages the depressed trajectory and continuous maneuvering program.
3	**Warhead bay (480–700 kg)**	The widest menu in this comparison: unitary HE, penetrator, cluster, thermobaric, and nuclear options.

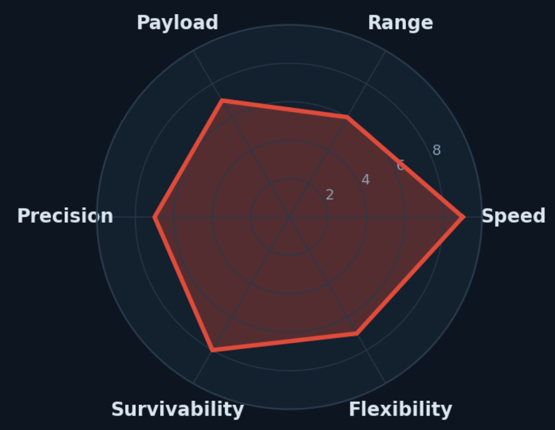
4	**Single-stage solid motor**	Composite-case solid propellant — fires within minutes of a halt, no fueling convoy needed.
5	**Control section**	Gas-dynamic vanes in the exhaust plus aerodynamic surfaces give control from launch through terminal dive.
6	**Penetration aids**	Reportedly dispenses decoys in the terminal phase to seduce interceptor seekers.

Schematic representation for educational purposes, compiled from open-source descriptions — not an engineering drawing; proportions and internal arrangement are illustrative.

KH-47M2 KINZHAL · "DAGGER"

AIR-LAUNCHED | AEROBALLISTIC | MACH 10 | DUAL-CAPABLE

The Kinzhal answers a simple question: what happens if you give a ballistic missile a 1,500 km head start? Carried by a modified MiG-31 flying high and fast, the missile ignites with enormous initial energy, reaching speeds near Mach 10 during boost. The aircraft adds two strategic advantages: reach (the carrier's combat radius extends total range toward 2,000 km) and unpredictability (launch can come from any azimuth, on short notice). Ukrainian Patriot PAC-3 batteries have demonstrated intercepts of the Kinzhal — an important data point — but each engagement consumes scarce, expensive interceptors, which is itself part of the attacker's calculus.



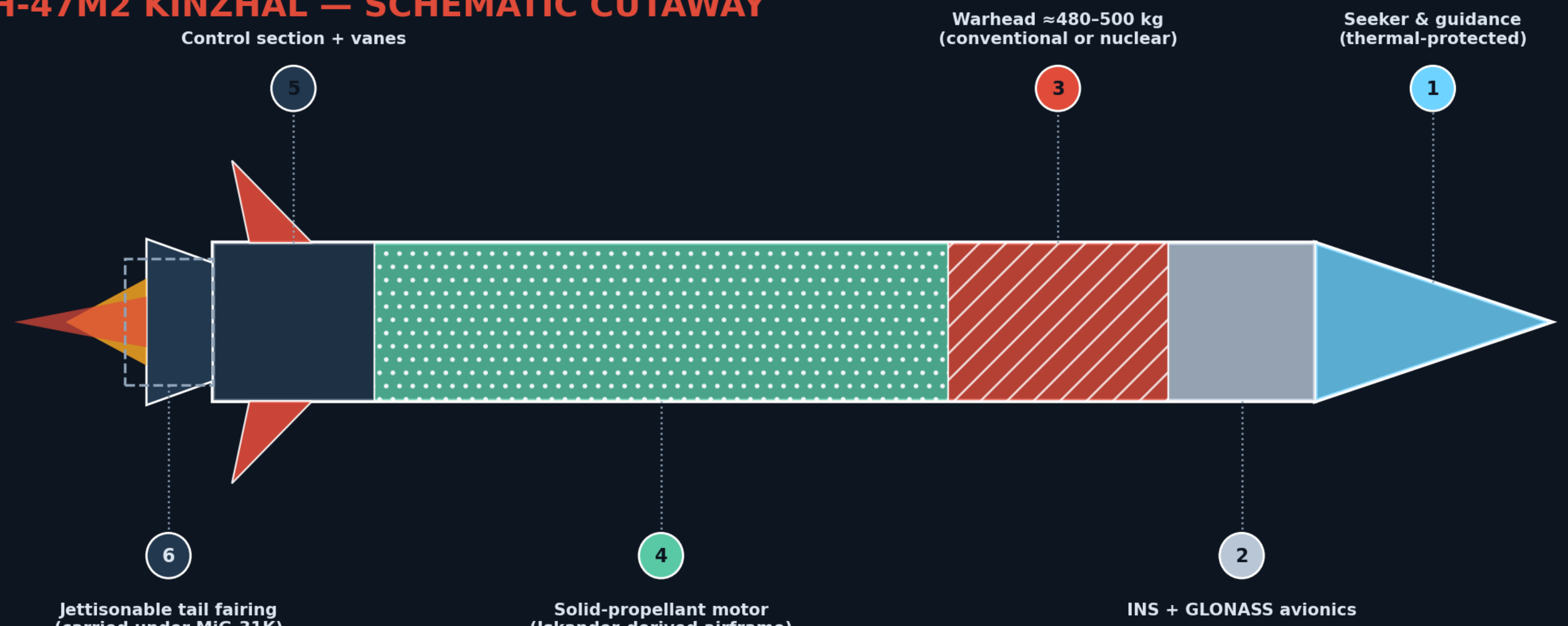
Qualitative profile (1–10, open-source assessment)

Class	Air-launched aeroballistic missile
Speed	Up to Mach 10 (boost); lower terminal velocity
Range	460–2,000 km incl. carrier combat radius
Warhead	≈480–500 kg, conventional or nuclear
Carrier	MiG-31K/I (primary); Tu-22M3 integration reported
Launch profile	Release at ≈12–15 km altitude and supersonic speed
Lineage	Iskander airframe adapted for air launch

DID YOU KNOW? 'Kinzhal' means 'dagger' in Russian. Its carrier, the MiG-31, was originally designed in the 1970s as a high-speed interceptor — now repurposed as a strike platform precisely because few aircraft can match its speed and ceiling at launch.

KH-47M2 KINZHAL — TECHNICAL CUTAWAY

KH-47M2 KINZHAL — SCHEMATIC CUTAWAY



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SENSORS / SEEKER · GUIDANCE & AVIONICS · WARHEAD / PAYLOAD · FUEL · ENGINE / SUSTAINER · BOOSTER / STAGES

1	Seeker & guidance nose	Hardened against the thermal loads of Mach 10 boost; supports both fixed and reported moving-target engagement.
2	INS + GLONASS avionics	Iskander-heritage guidance adapted for air launch initialization from the carrier's navigation system.
3	Warhead (≈480–500 kg)	Conventional or nuclear — the payload ambiguity is strategically deliberate.

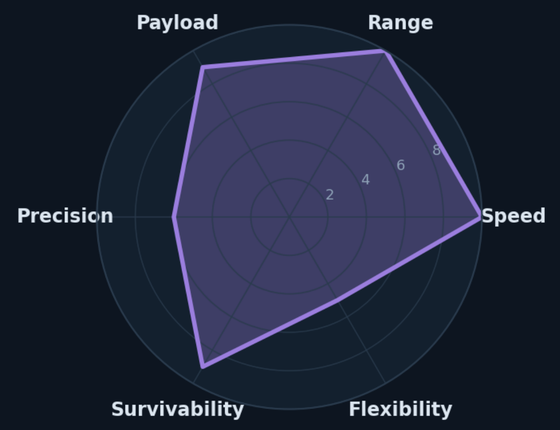
4	Solid-propellant motor	The Iskander-derived motor ignites after release, adding Mach 10-class boost to the aircraft's existing speed and altitude.
5	Control section + vanes	Maneuvering through boost and descent complicates fire-control solutions.
6	Jettisonable tail fairing	Streamlines the missile during carriage under the MiG-31K; discarded at motor ignition.

Schematic representation for educational purposes, compiled from open-source descriptions — not an engineering drawing; proportions and internal arrangement are illustrative.

ORESHNIK · IRBM · MIRV

IRBM | MIRV | KINETIC SATURATION | MACH 10+

The Oreshnik ('hazel tree') is the newest and, in regional terms, the most consequential system in this comparison. Its November 2024 combat demonstration against Dnipro was unprecedented: the first operational use of a MIRV-equipped missile in war. Each of its six reentry vehicles dispenses submunitions — dense kinetic penetrators arriving at Mach 10+ — producing a saturation pattern of dozens of near-simultaneous impacts. Even without explosive fill, the kinetic energy per penetrator is sufficient to defeat hardened structures. From central Russia its 3,500–5,500 km reach covers all of Europe, placing it at the center of the post-INF-Treaty debate about intermediate-range systems on the continent.

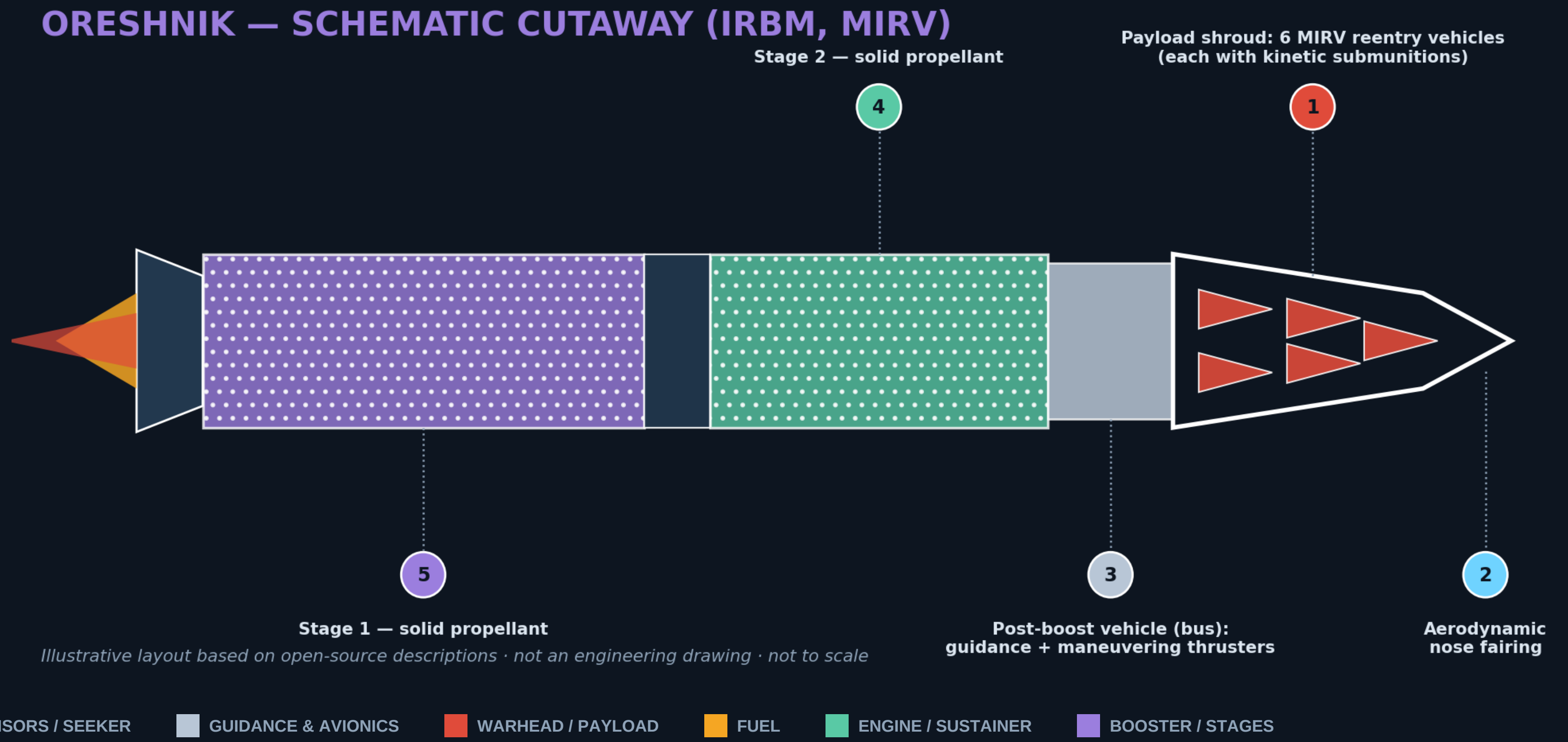


Qualitative profile (1–10, open-source assessment)

Class	Intermediate-range ballistic missile (IRBM)
Speed	Mach 10–11 (terminal, per RV)
Range	3,500–5,500 km
Payload	6 MIRVs, each with multiple submunitions (kinetic penetrators)
Lineage	Reported derivative of RS-26 Rubezh program
Platform	Road-mobile transporter-erector-launcher
Combat debut	Dnipro, Ukraine — 21 November 2024

DID YOU KNOW? In the Dnipro strike, the Oreshnik's warheads carried no explosives at all — the destruction observed came purely from kinetic energy, a deliberate demonstration of what Mach 10+ mass alone can do.

ORESHNIK — TECHNICAL CUTAWAY

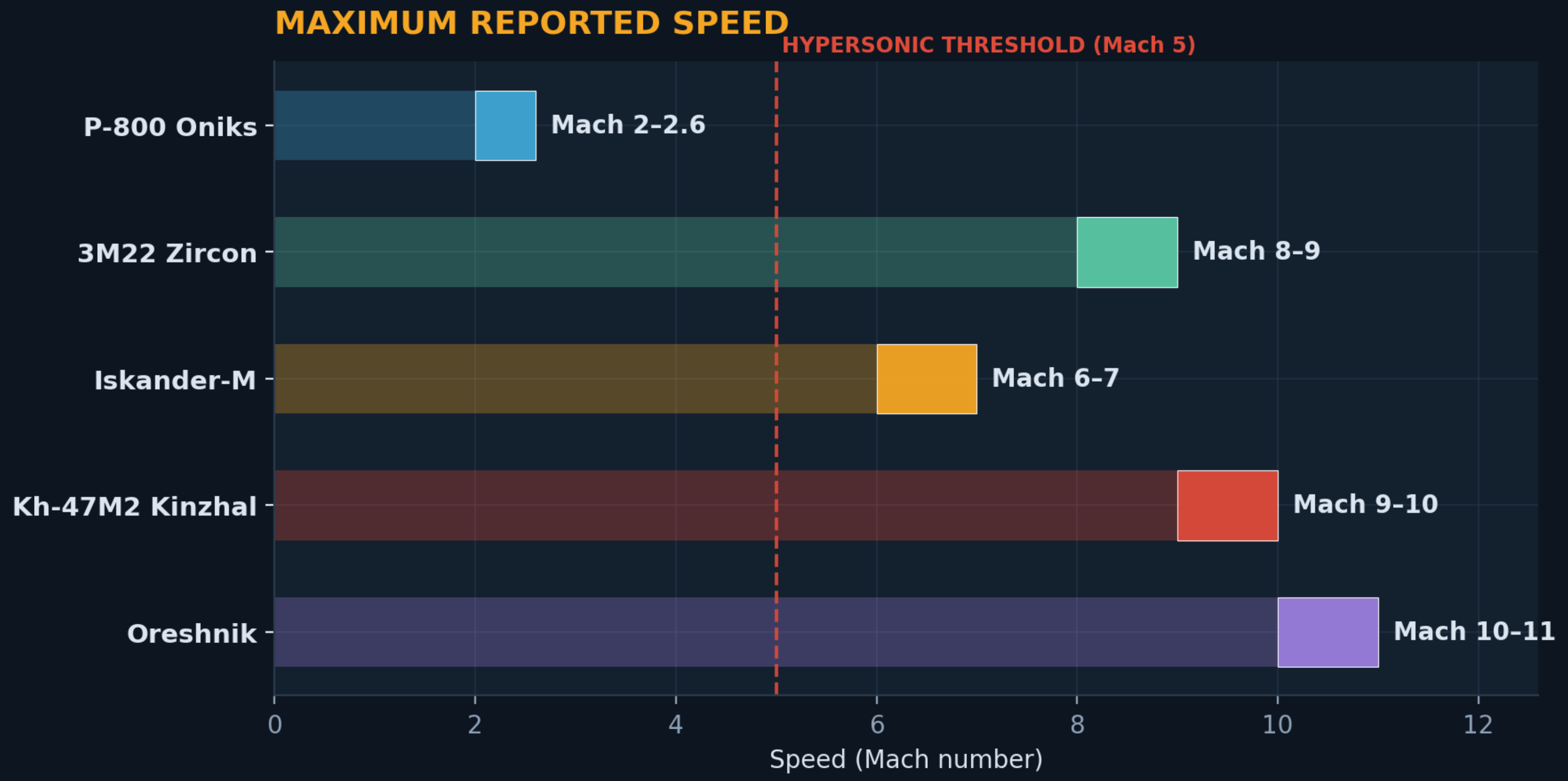


1	Payload shroud with 6 MIRVs	Six conical reentry vehicles, each reported to carry multiple kinetic submunitions — up to ~36 impactors per missile.
2	Nose fairing	Protects the RV cluster during atmospheric ascent; ejected in vacuum.
3	Post-boost vehicle (bus)	Small maneuvering stage that points and releases each RV onto its own target track — the technology that defines 'independently targetable'.

4	Stage 2 — solid propellant	Completes boost to ≈3 km/s-class burnout velocity for intermediate range.
5	Stage 1 — solid propellant	Reported RS-26 Rubezh lineage; solid fuel enables road-mobile basing and minutes-scale launch readiness.

Schematic representation for educational purposes, compiled from open-source descriptions — not an engineering drawing; proportions and internal arrangement are illustrative.

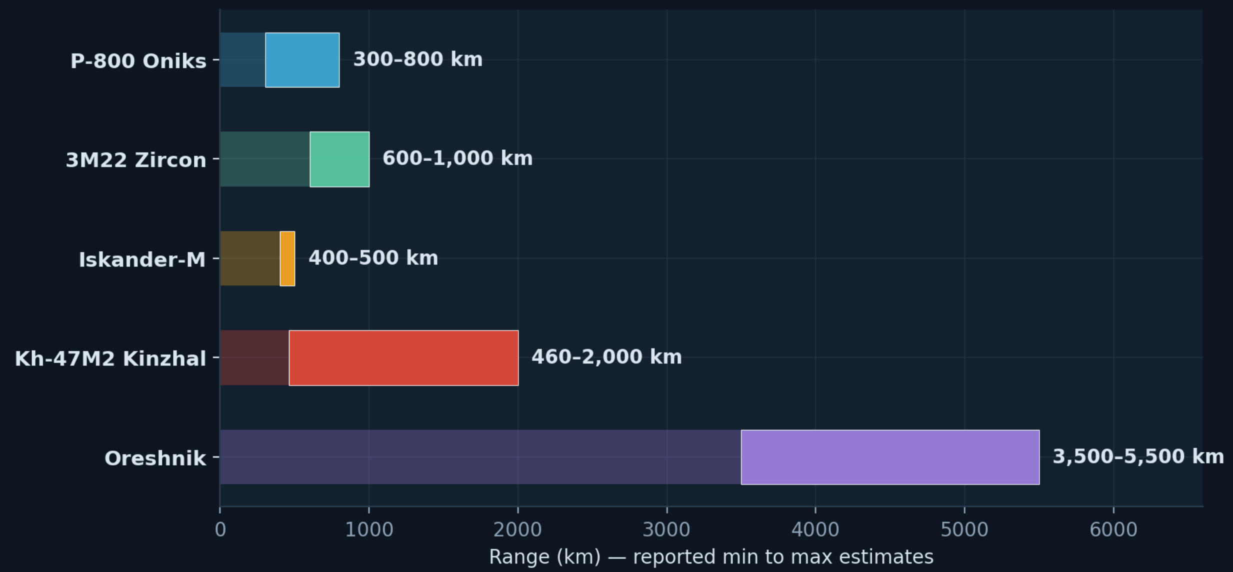
SPEED — THE HYPERSONIC DIVIDE



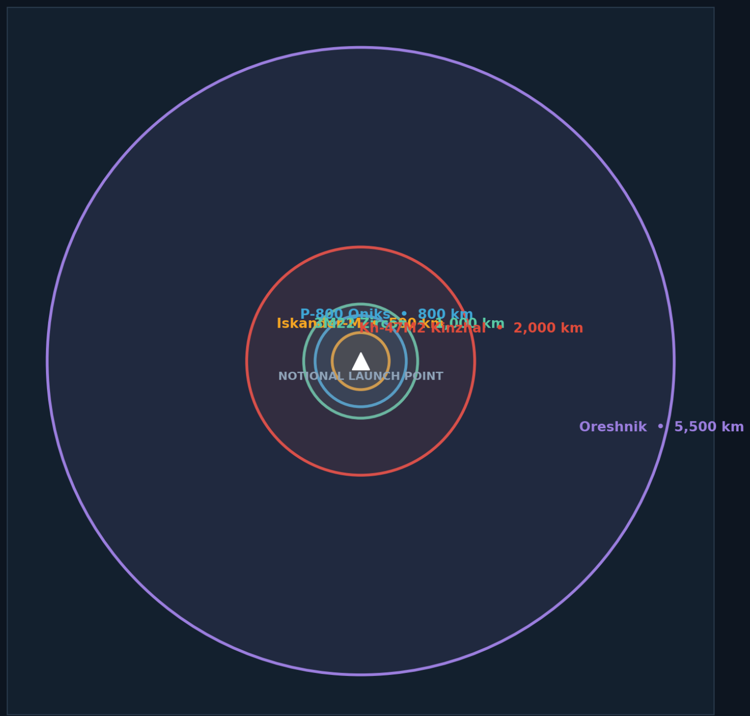
WHAT MACH NUMBERS REALLY MEAN. 'Hypersonic' formally begins at Mach 5, but the operationally meaningful threshold is what speed does to defense timelines. At Mach 2.5, the Oniks crosses 100 km in about two minutes — tight, but workable for an alerted defender. At Mach 9–11, that same distance falls to roughly 30 seconds. Detection, classification, track establishment, engagement authorization, and interceptor fly-out must all fit inside that window. Note also that peak speed is not terminal speed: aeroballistic weapons like the Kinzhal bleed velocity in the dense lower atmosphere, which is one reason terminal-phase intercepts of it have proven feasible for PAC-3-class systems.

RANGE — FROM TACTICAL TO CONTINENTAL

OPERATIONAL RANGE ENVELOPE

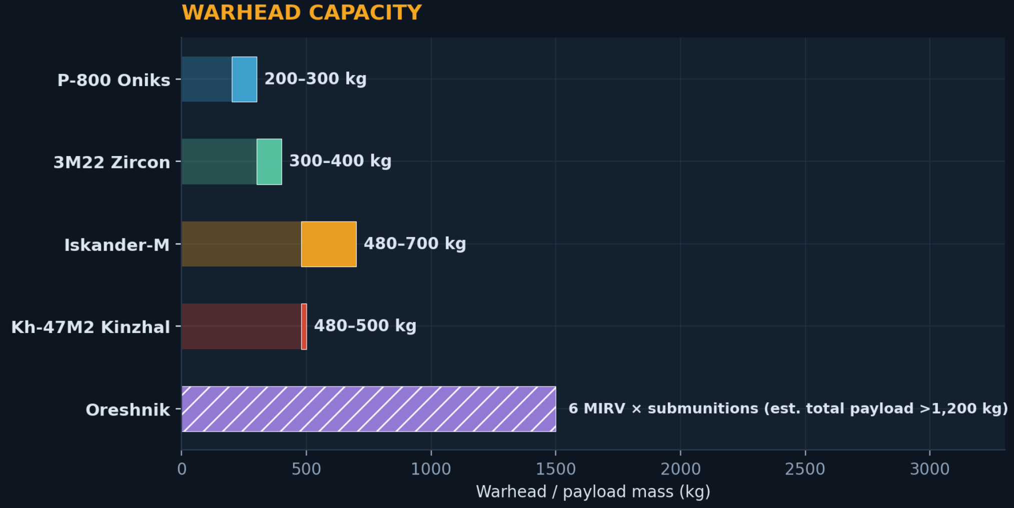


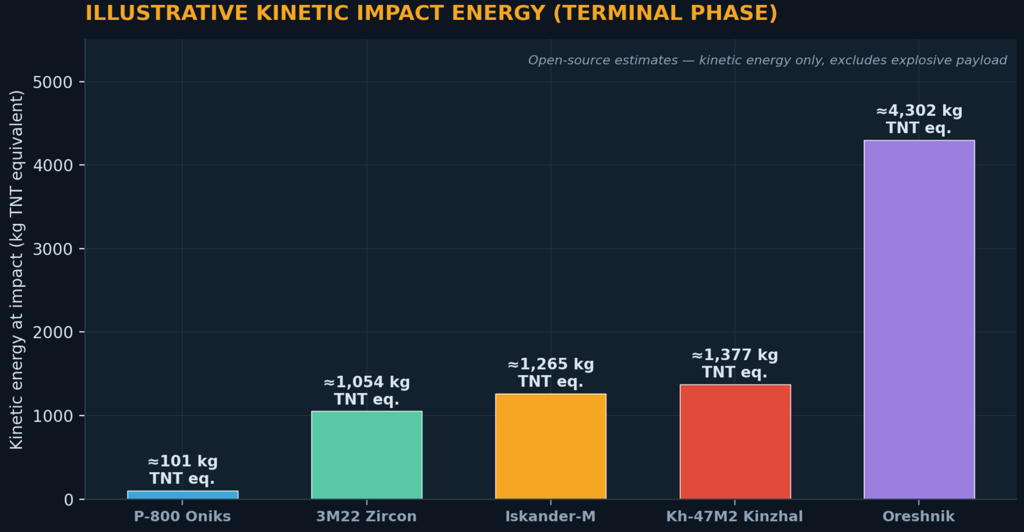
MAXIMUM RANGE FOOTPRINTS (SCHEMATIC)



THREE DISTINCT LEAGUES. The Oniks, Zircon and Iskander-M are theater weapons: they shape battles within roughly 1,000 km. The Kinzhal, thanks to its carrier aircraft, stretches into the operational-strategic tier, holding rear-area infrastructure at risk across a whole region. The Oreshnik plays in a different league entirely — its 3,500–5,500 km envelope is continental, covering every European capital from launch sites deep inside Russia, where the launcher itself is far harder to find and strike. Range, in other words, is not just about distance: it determines which targets are holdable, and how survivable the shooter is.

WARHEADS & KINETIC IMPACT





WHEN SPEED BECOMES THE WARHEAD. Kinetic energy grows with the *square* of velocity ($E = \frac{1}{2}mv^2$) — double the speed, quadruple the energy. This is why the comparison between systems cannot stop at warhead mass. The Iskander-M carries the heaviest conventional unitary warheads (up to 700 kg), but a Zircon arriving at ~2 km/s delivers impact energy on the order of a metric ton of TNT before its explosive fill even detonates. The Oreshnik takes this logic to its conclusion: its submunitions carry *no explosives at all*, relying purely on Mach 10+ kinetic penetrators to defeat hardened targets — and distributing that energy across dozens of impact points to saturate an area target.

Kinetic figures are illustrative order-of-magnitude estimates based on open-source mass and terminal-velocity assumptions; they exclude explosive payload effects.

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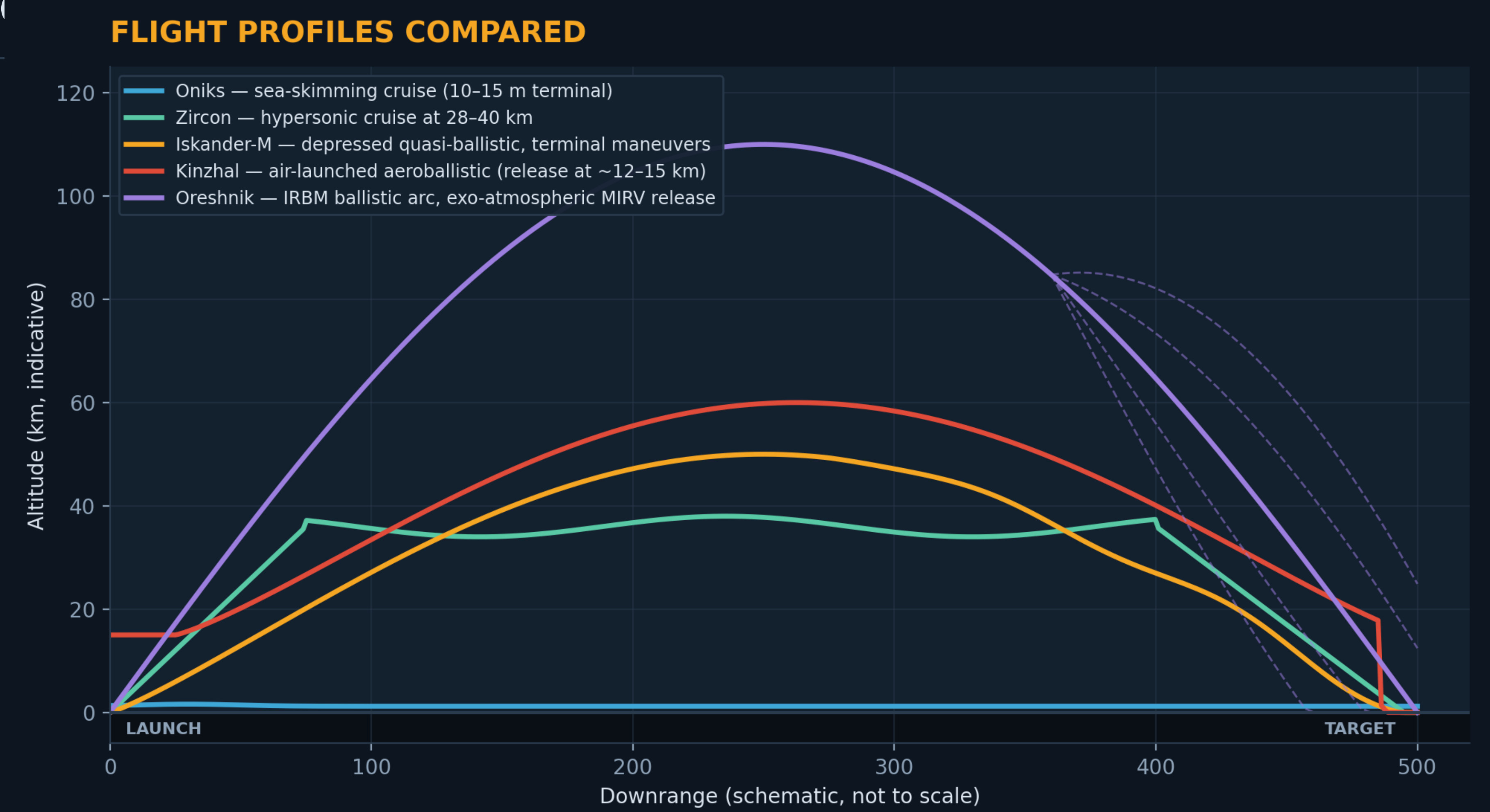
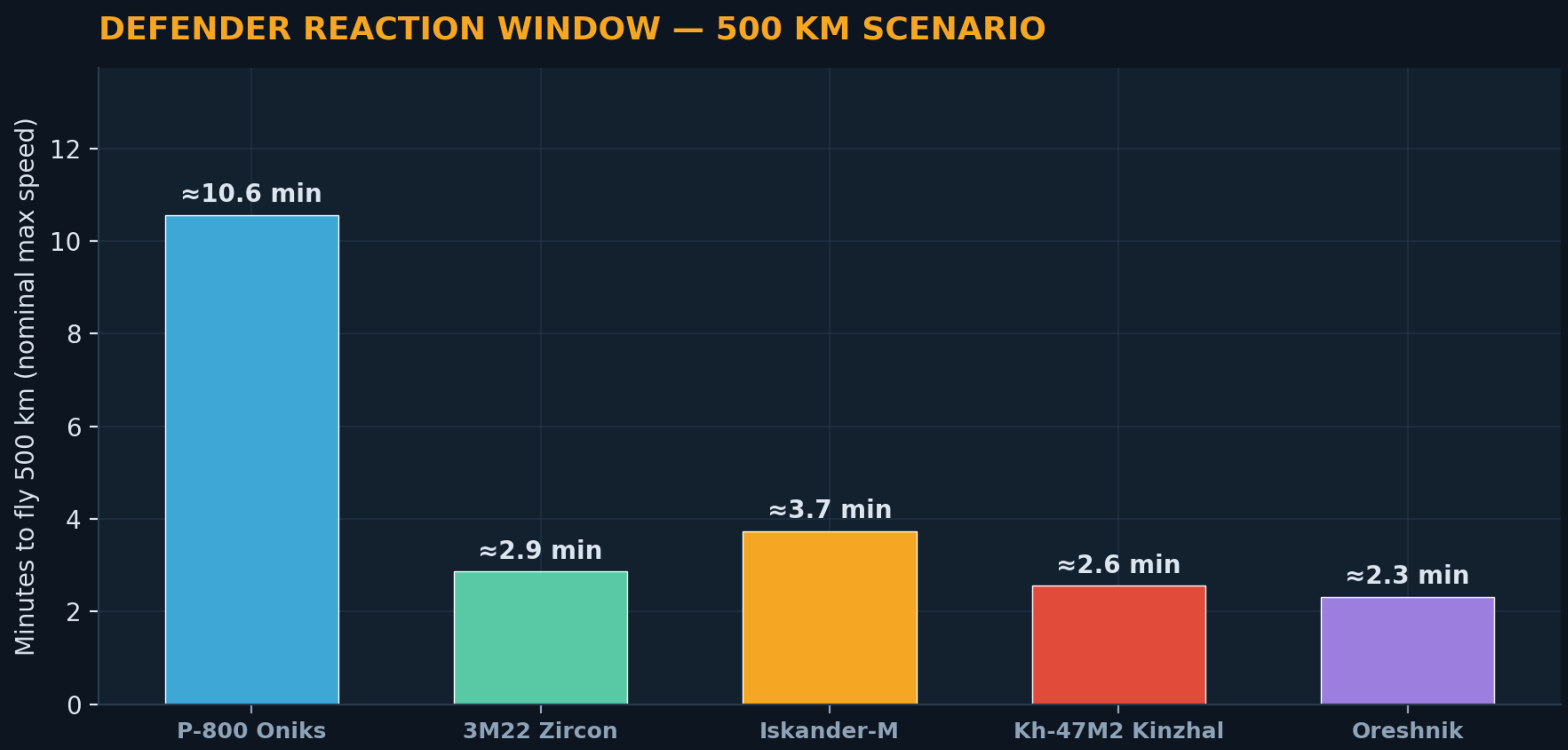


GEOMETRY IS DESTINY. Each profile attacks a different weakness in layered defense. Sea-skimmers hide below the radar horizon. Hypersonic cruisers fly *between* the engagement envelopes of endo-atmospheric SAMs and exo-atmospheric interceptors. Quasi-ballistic maneuvering defeats trajectory prediction. Air launch randomizes the threat axis. And a MIRV bus turns one inbound track into many — forcing the defender to spend multiple interceptors per missile launched, an exchange ratio that rapidly exhausts magazines.

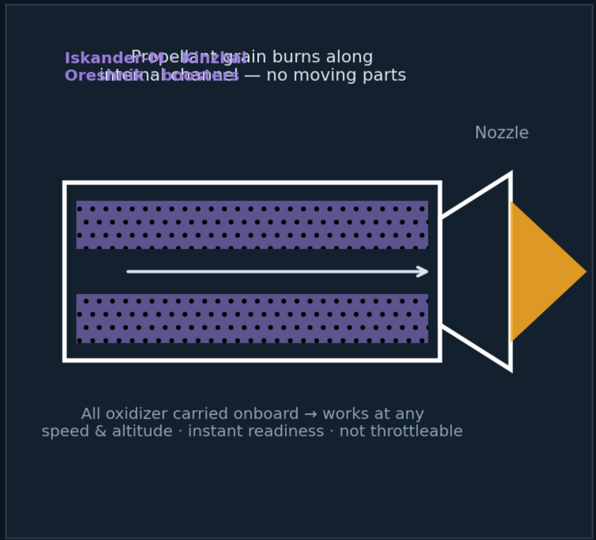
THE DEFENDER'S CLOCK



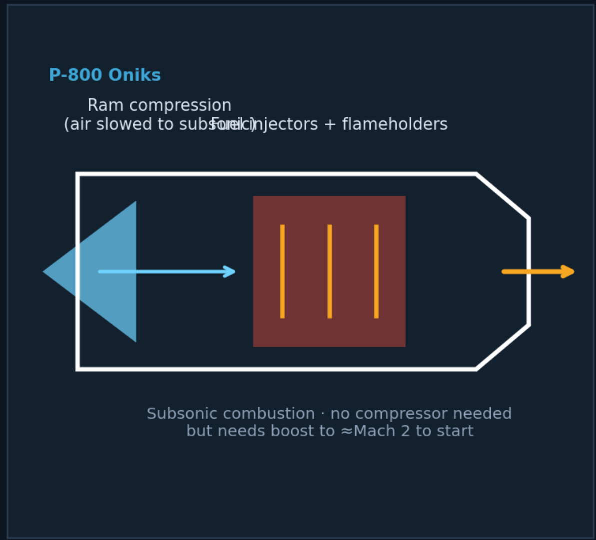
COMPRESSED DECISION CYCLES. The chart shows nominal flight time over a 500 km leg at each system's headline speed. In practice the usable warning time is even shorter: low-flyers are detected late (radar horizon), ballistic systems require track confirmation before engagement, and human authorization consumes precious seconds. Against the fastest systems, meaningful point defense increasingly implies pre-delegated engagement authority and automated decision loops — with all the escalation-stability questions that automation raises. This time compression, more than any single technical trait, is the strategic signature of the hypersonic era.

DEEP DIVE · PROPULSION TECHNOLOGIES

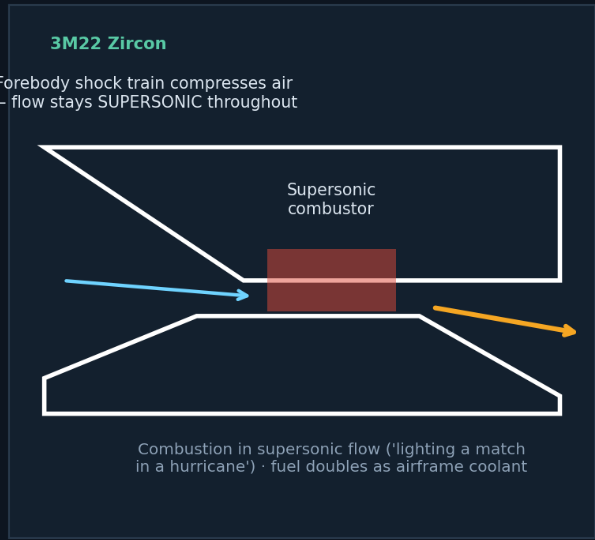
SOLID ROCKET MOTOR



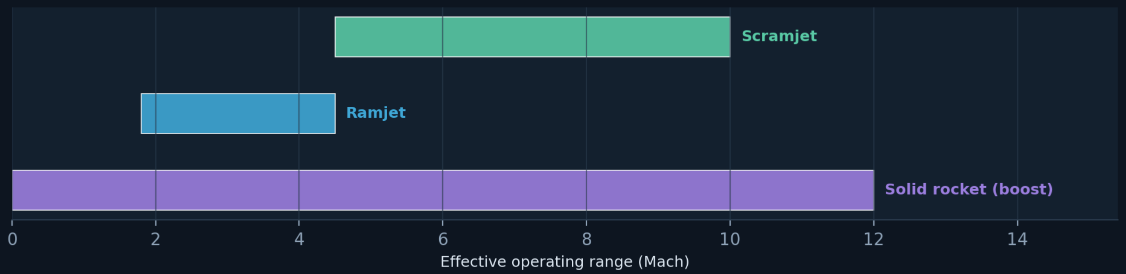
RAMJET (Mach ≈2–4 cruise)



SCRAMJET (Mach 5+ cruise)



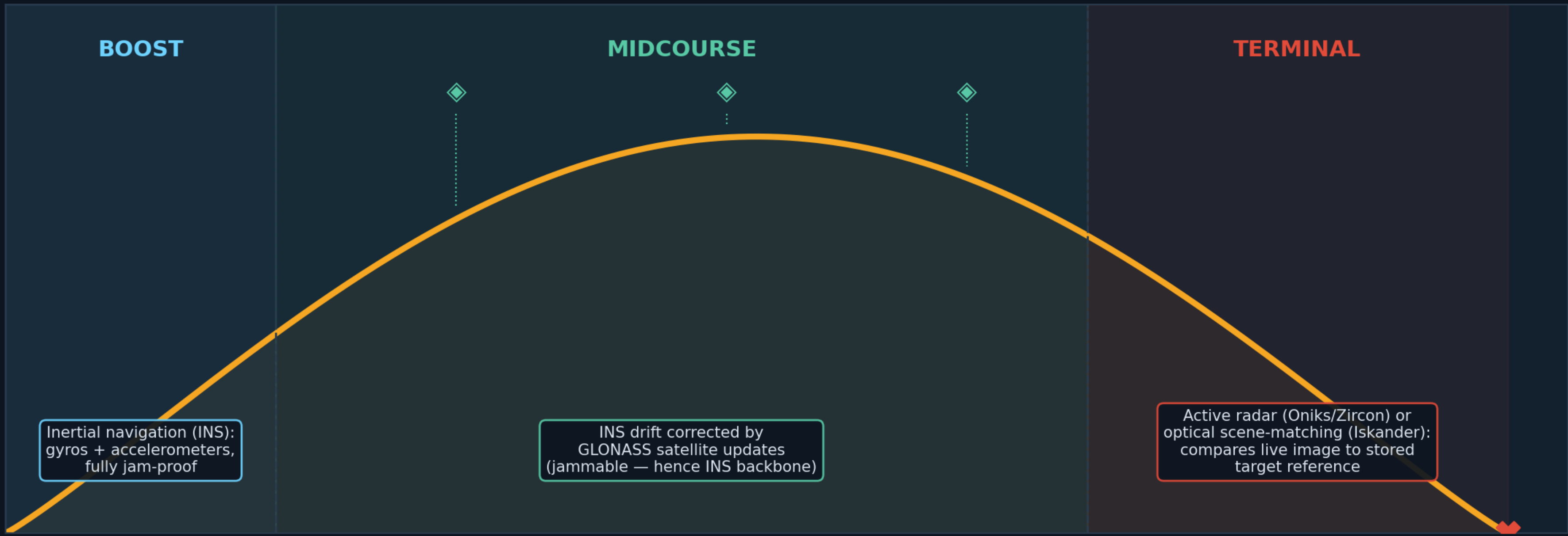
PROPULSION OPERATING ENVELOPES



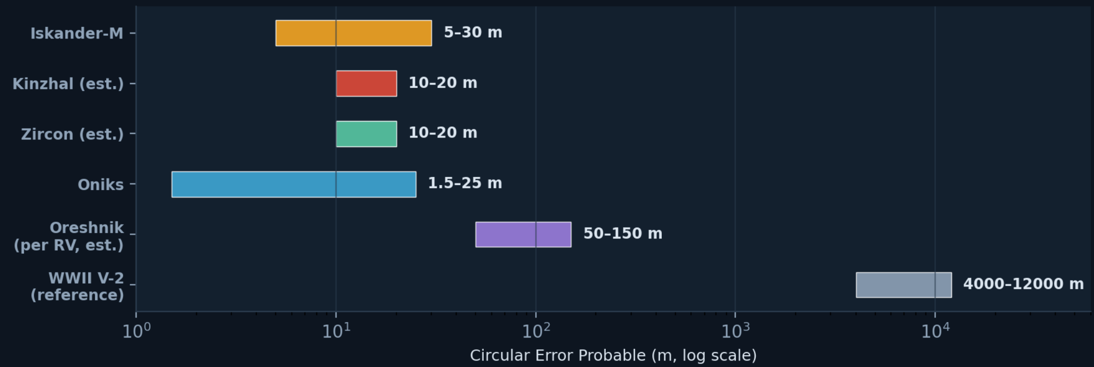
THE ENGINE DEFINES THE MISSILE. Solid rockets deliver violent acceleration and total readiness, but burn out in seconds — perfect for ballistic and aeroballistic profiles (Iskander, Kinzhal, Oreshnik). Air-breathing engines trade thrust for endurance: by taking oxygen from the atmosphere they need no oxidizer tank, so a ramjet (Oniks) or scramjet (Zircon) can *cruise* and *maneuver* along the whole route. The scramjet is the hard one: keeping a flame lit in airflow moving faster than sound took decades of research — which is why sustained hypersonic cruise remained theoretical until the 2020s.

DEEP DIVE · GUIDANCE & PRECISION

GUIDANCE CHAIN — THREE PHASES TO A 10-METER CEP



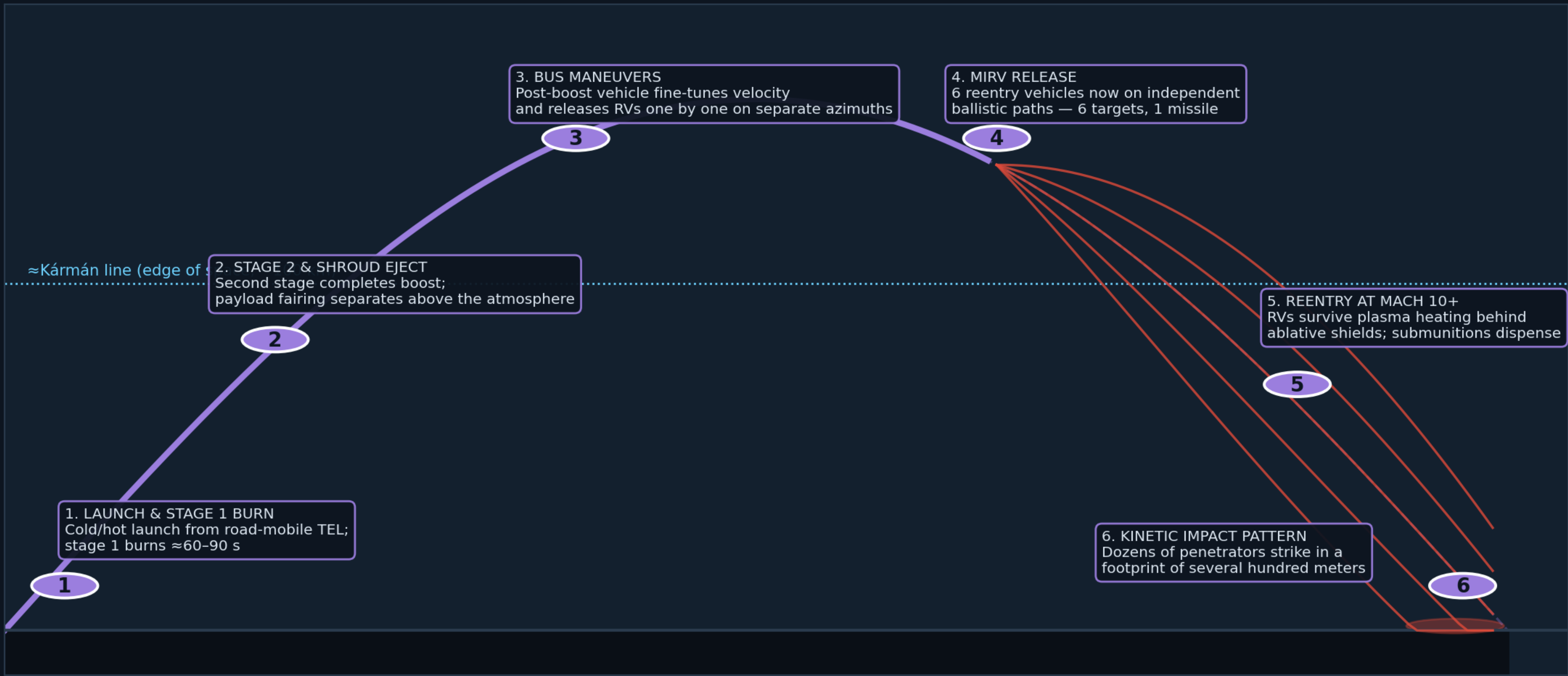
PRECISION COMPARED (CEP)



ACCURACY IS A CHAIN, NOT A PART. Every system here layers three navigation methods. The inertial core cannot be jammed but drifts with time; satellite updates cancel the drift but can be denied; the terminal seeker delivers the final meters of precision. Iskander-M's optical scene-matching is the standout: because it compares what it *sees* to a stored image, GPS/GLONASS jamming barely degrades it. The historical comparison tells the story of the precision revolution: a WWII V-2 missed by kilometers; an Iskander hits a specific building. Precision is what converts a warhead from a terror weapon into a military instrument — and what allows smaller warheads to achieve effects that once required much larger ones.

DEEP DIVE · ANATOMY OF A MIRV STRIKE

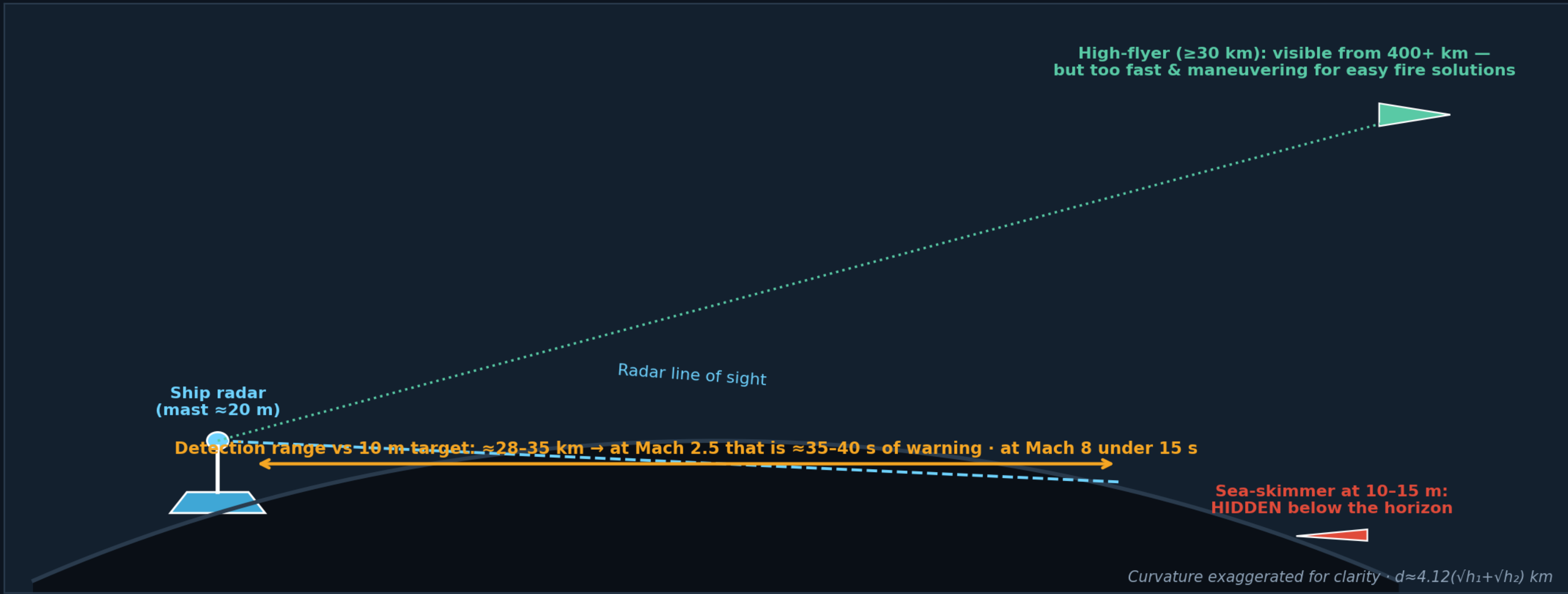
ORESHNIK MIRV STRIKE SEQUENCE (SCHEMATIC)



WHY MIRV CHANGES THE MATH. A single Oreshnik presents a defender not with one target but with six independent reentry vehicles — and each RV then dispenses multiple submunitions that cannot be individually engaged at all. If doctrine assigns two interceptors per credible object, one missile can absorb a dozen high-end interceptors. The November 2024 Dnipro strike demonstrated the full sequence in combat for the first time anywhere: observers counted six clusters of six impacts each, arriving within seconds. MIRV technology on an IRBM, with conventional kinetic payloads, is a category that simply did not exist before.

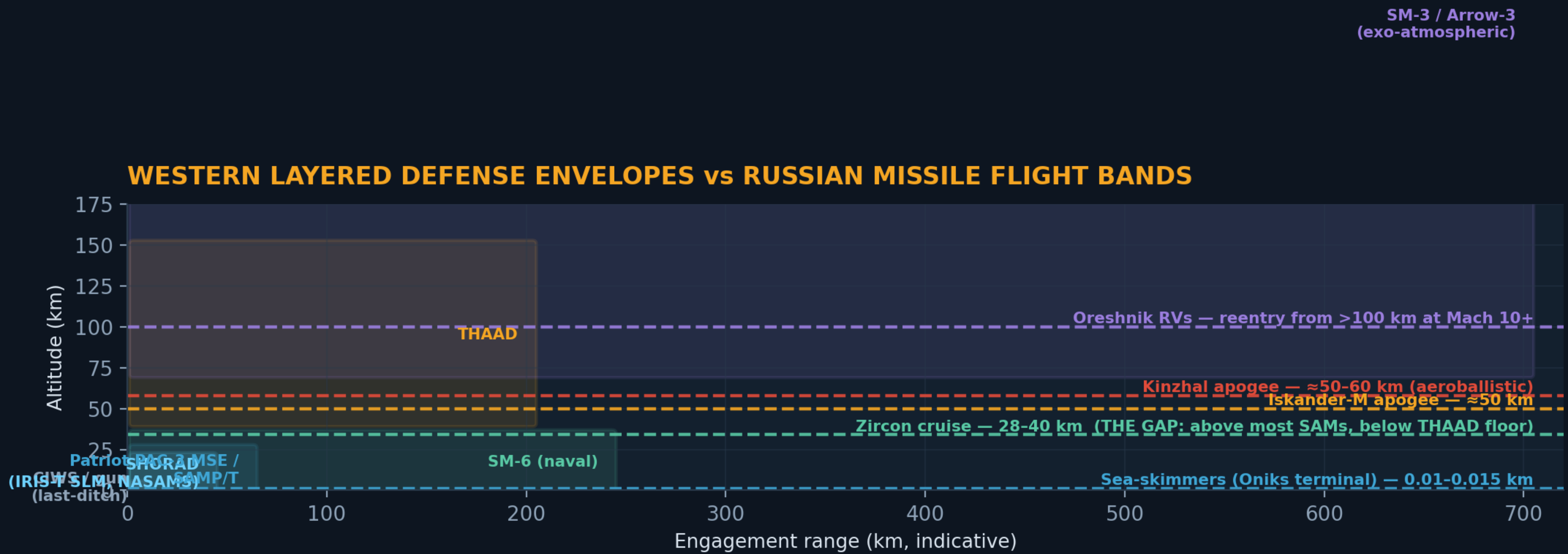
DEEP DIVE · THE RADAR HORIZON PROBLEM

WHY ALTITUDE = WARNING TIME — THE RADAR HORIZON PROBLEM



GEOMETRY YOU CANNOT ENGINEER AWAY. Radar is line-of-sight, and the Earth is round: a mast-mounted radar simply cannot see a wave-hugging missile beyond ≈30 km, no matter how powerful it is. This is the physics that has kept the 60-year-old sea-skimming concept lethal — and why the Oniks terminal profile still works against modern ships. The defender's counters are all about raising the sensor: airborne early-warning aircraft, aerostat radars, and now proliferated satellite constellations that look *down*, turning the horizon problem inside out. High-flyers like Zircon accept early detection in exchange for speed and an altitude band where few interceptors can reach — two opposite answers to the same survival question.

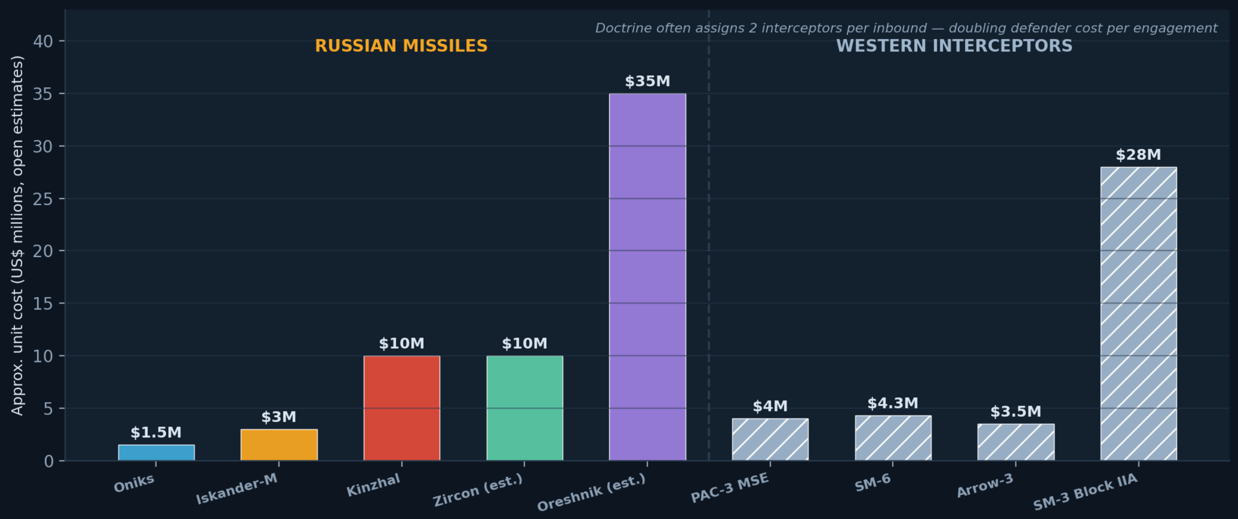
DEEP DIVE · LAYERED DEFENSE vs FLIGHT BANDS



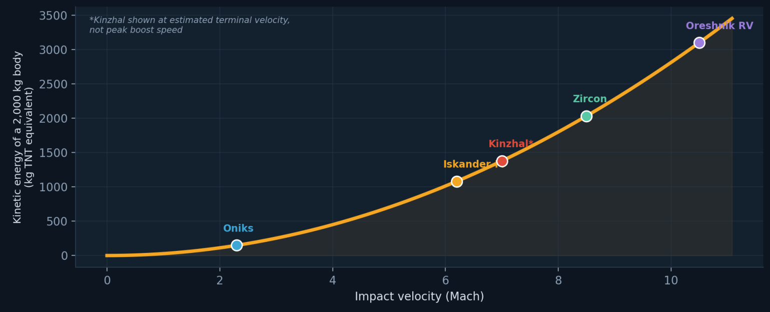
READING THE GAPS. Overlaying Western engagement envelopes on Russian flight bands reveals the design logic of each missile. The Zircon's 28–40 km cruise band sits *above* the ceiling of Patriot-class systems yet *below* THAAD's minimum engagement altitude — a deliberately chosen seam. Sea-skimmers exploit the horizon rather than altitude. Iskander and Kinzhal transit the PAC-3 envelope only briefly and while maneuvering, compressing the firing solution to seconds. Oreshnik-class RVs are exo-atmospheric for most of their flight, where only SM-3/Arrow-3-class interceptors operate — systems deployed in small numbers and costing tens of millions per round.

DEEP DIVE · COST-EXCHANGE ECONOMICS

THE COST-EXCHANGE PROBLEM



$E = \frac{1}{2}mv^2$ — WHY VELOCITY BEATS MASS

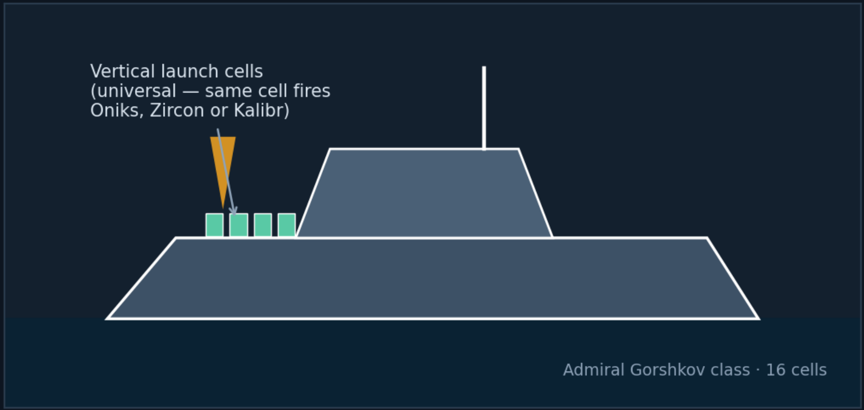


ATTRITION IS A BUDGET LINE. Missile defense works engagement by engagement but can fail as a campaign: when a $3M Iskander draws two $4M PAC-3s, every successful intercept still costs the defender more than the attacker — and interceptor production lines are slower than missile lines. The exception proves the rule: the cheap, ubiquitous drone swarms accompanying missile salvos in Ukraine exist precisely to drain interceptor magazines before the expensive shots arrive. The right side chart shows the physics driving payload design: because energy scales with velocity squared, a Mach 10 penetrator carries ≈20× the specific energy of a Mach 2.3 one — which is how the Oreshnik can dispense with explosives entirely.

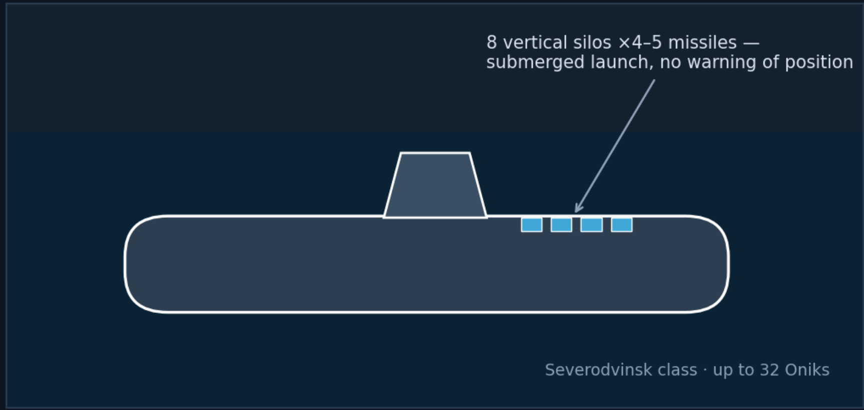
Unit costs are open-source estimates and vary significantly by source, year, and production batch.

DEEP DIVE · LAUNCH PLATFORMS

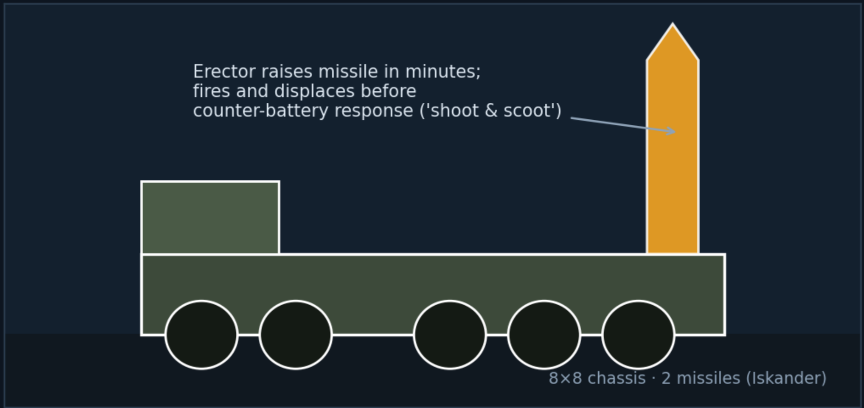
SURFACE SHIP — 3S-14 VLS (Oniks · Zircon · Kalibr family)



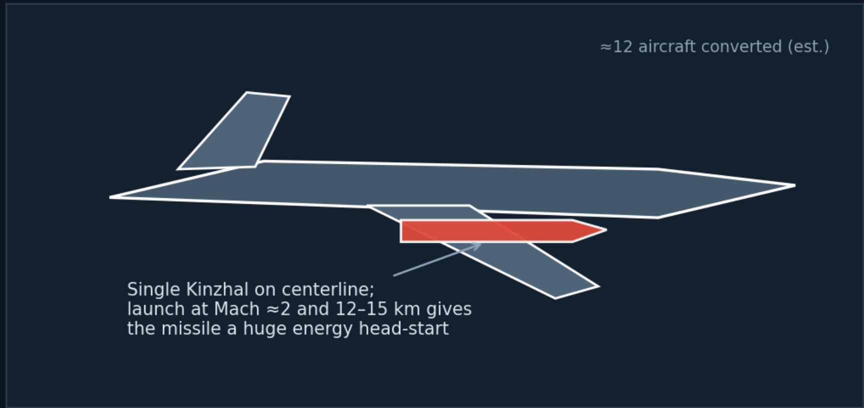
SUBMARINE — Yasen-class SSGN (Oniks · Zircon)



ROAD-MOBILE TEL (Iskander-M 9P78-1 · Oreshnik launcher)



AIRBORNE — MiG-31K/I (Kinzhal)



THE LAUNCHER IS HALF THE WEAPON. Basing determines survivability and surprise. Universal naval VLS cells mean a defender cannot know a ship's loadout; a submarine hides the launch point itself; a road-mobile TEL vanishes into the road network between salvos ('shoot and scoot'); and an air launch turns the entire combat radius of a Mach 2.8 interceptor into a launch zone. Targeting the archers rather than the arrows is the classic counter — but each of these basing modes was chosen precisely to make that hard.

STRATEGIC ASSESSMENT

SPEED & REACH LEADERS

The **Oreshnik** and **Kinzhal** currently represent the pinnacle in speed and destructive reach. The Oreshnik in particular blurs the line between theater and strategic weapons: MIRV saturation at intermediate range with conventional (kinetic) payloads is a genuinely new category, deliberately positioned below the nuclear threshold while borrowing the signaling weight of strategic systems.

NAVAL DENIAL SPECIALIST

The **Zircon** excels in the maritime domain. Against carrier strike groups, its combination of speed, altitude band and plasma-degraded radar cross-section stresses even Aegis-class layered defenses, and it extends Russia's anti-access/area-denial (A2/AD) bubbles from the Barents to the Black Sea. Its land-attack use in Ukraine appears opportunistic rather than doctrinal.

THE PROVEN WORKHORSES

The **Iskander-M** and **Oniks** deliver most of Russia's actual precision-strike output. Combat experience has driven iterative upgrades — decoys, revised terminal maneuvers, seeker improvements — in a live feedback loop with Western air defenses. Mass, not novelty, is their strategic argument: a defense can be exhausted by volume as surely as it can be defeated by speed.

THE COMMON THREAD. These systems collectively underscore Russia's emphasis on hypersonic and maneuvering technologies to reduce adversary reaction times and overwhelm defenses — a compensation strategy for conventional-force disadvantages elsewhere. Three implications stand out. **(1) Cost asymmetry:** interceptors typically cost several times more than the missiles they engage, making attrition economics favor the attacker. **(2) Sensor architecture:** countering low-flying hypersonics requires elevated and space-based tracking layers (e.g., proliferated LEO constellations), not just more ground radars. **(3) Arms-control vacuum:** with the INF Treaty defunct, intermediate-range systems like Oreshnik face no treaty constraints, and reciprocal deployments in Europe and Asia are already reshaping regional postures.

IMPLICATIONS FOR GLOBAL DEFENSE POSTURES

LAYERED, ELEVATED SENSING

Ground radars alone cannot maintain custody of maneuvering hypersonic targets. Expect accelerated investment in space-based missile-tracking layers, over-the-horizon radar, and airborne sensors — and in the data fusion needed to hand tracks between them in seconds.

INTERCEPTOR ECONOMICS & DIRECTED ENERGY

The cost-exchange problem pushes defenders toward cheaper effectors: gun-based C-RAM at the terminal layer, lower-cost interceptor designs, and eventually directed-energy weapons whose per-shot cost is measured in dollars rather than millions.

PASSIVE DEFENSE RENAISSANCE

Dispersal, hardening, deception and mobility regain importance when interception cannot be guaranteed. Fixed high-value infrastructure — airbases, ports, command nodes — is the natural prey of precision ballistic systems; resilience is the counter.

LEFT-OF-LAUNCH & COUNTERFORCE

If missiles are hardest to stop in flight, pressure grows to defeat them before launch: strikes on TELs and arsenals, electronic warfare against guidance, cyber operations against kill chains. Each carries its own escalation risks.

DETERRENCE & ARMS-CONTROL STAKES

Dual-capable systems (Iskander, Kinzhal, Oreshnik) compress the conventional-nuclear signaling space: a defender cannot know the payload until impact. This ambiguity is strategically deliberate — and it strengthens the case for renewed intermediate-range transparency measures, however remote they seem today.

GLOSSARY, METHODOLOGY & CAVEATS

Hypersonic	Speed above Mach 5 (≈6,175 km/h at sea level). The operationally relevant trait is sustained maneuverable hypersonic flight, not peak speed alone.
Quasi-ballistic	A ballistic-launched missile flying a depressed, powered/maneuvering trajectory that never fully leaves the atmosphere (e.g., Iskander-M).
Aeroballistic	Air-launched missile following a ballistic-style arc after release from an aircraft (e.g., Kinzhal).
Scramjet	Supersonic-combustion ramjet: an air-breathing engine enabling sustained cruise above ≈Mach 5 (e.g., Zircon).
MIRV	Multiple Independently-targetable Reentry Vehicles — one missile delivering several warheads to separate aim points (e.g., Oreshnik).
CEP	Circular Error Probable — radius around the aim point within which 50% of rounds are statistically expected to land.
IRBM / SRBM	Intermediate-Range (3,000–5,500 km) / Short-Range (<1,000 km) Ballistic Missile.
A2/AD	Anti-Access / Area Denial — layered capabilities designed to keep adversary forces out of a region or restrict their freedom of action within it.
TEL	Transporter-Erector-Launcher — the road-mobile vehicle that carries, raises and fires the missile.
Plasma stealth	Ionized air sheath formed around bodies at extreme speed, which can absorb/scatter radar energy and degrade tracking.

METHODOLOGY & CAVEATS. All figures are compiled from open, publicly available sources (defense press, institute analyses, official statements). Manufacturer and government claims — particularly for speed, range and accuracy — are frequently unverifiable and sometimes inflated; where estimates diverge, ranges are shown rather than point values. Kinetic-energy figures are illustrative order-of-magnitude calculations, not measured data. Qualitative radar-chart scores reflect the author's synthesis of open-source assessments and should be read as relative, not absolute. This document is an analytical overview intended for strategic-level discussion; it contains no technical design information.