MARS EXPLORATION

Concept Study for a Reusable Claim-17 Interplanetary Transport

120 m rotating habitat - modular high-power propulsion - scalable crew and cargo

Origin. This concept study was developed in technical dialogue between Zoran Ozimec - inventor and owner of U.S. Patent No. 12,674,441 B2, with three additional U.S. provisional patent applications filed as Nos. 64/128,198; 64/147,166; and 64/149,475 - and OpenAI ChatGPT, GPT-5.6 Sol.

Reference spacecraft	120 m centerline-diameter rotating ring; nominal 20 m axial habitat width; whole reference vehicle rotates as one rigid spacecraft assembly.
Artificial gravity	Variable by rotation rate: begin outbound near 1g, progressively reduce toward Mars gravity (0.38g) before arrival; reverse the schedule on return to Earth. At 60 m radius this corresponds to about 3.86 rpm down to 2.37 rpm.
Mission mass	About 1,200 t nominal for screening; deliberately scalable to well over 2,000 t with longer transit.
People	Mission configurable: specialist expeditions through several hundred passengers; about 500 people is a representative high-capacity transport configuration.
Propulsion	Twelve modular Claim-17 flight engines derived from the fixed 1 kN development reference.
Power	Four independent conceptual modified naval-variant reactor/power modules. Electrical output is a mission variable rather than a single fixed number.
Service philosophy	Persistent reusable transport; nominal nuclear refueling/core-service target about 25 years.
Conventional material reaction mass	None in the proposed Claim-17 architecture.

Working premise. This study examines the Mars exploration vehicle worth engineering only if a Claim-17 prototype returns a positive result consistent with *Claim-17 Prototype Options* and *Where Does the Opposite Momentum Go? FINAL.*

1. People and cargo: one vehicle, many mission configurations

The 120 m habitat ring supports a wide range of crew configurations. With the central axis and the broad interior volume enclosed by the ring largely reserved for cargo, power systems and machinery, the ring can be used primarily as a human-transport habitat when desired. Axial ring width is deliberately scalable: increasing it adds pressurized volume without changing radius, rotation rate or the central propulsion aperture.

Axial ring width	Gross ring volume	Two-deck floor area	Representative people	Representative use
10 m	22,600 m^3	7,540 m^2	200-300	specialist / cargo-heavy
20 m	45,200 m^3	15,100 m^2	400-600	baseline high-capacity
30 m	67,900 m^3	22,600 m^2	600-900	personnel transport
40 m	90,500 m^3	30,200 m^2	800-1,200	growth configuration

The exploration vehicle can therefore span roughly 20 specialist crew through several hundred passengers without changing the basic spacecraft, while a human-transport configuration around 500 people fits comfortably in the 20 m axial ring at the geometric level. Larger complements remain possible by widening the ring and accepting the corresponding mass and transit-time penalty.

Cargo is similarly scalable. The approximately 71.7 m clear central diameter through the engine annulus, together with the large low-gravity volume enclosed by the habitat ring and the generous forward/aft axial volume, provides room for surface vehicles, laboratories, spares, logistics, shielding reserves and mission-specific payloads. Cargo does not require artificial gravity, so the broad central region is naturally suited to dense storage and direct access from the ring. Heavy missions above 2,000 t do not require a different propulsion architecture; they primarily trade acceleration for travel time.

Operational principle. MEX-1 is better understood as a reusable transport class than as a single mission vehicle: scientific expedition, heavy cargo run, mixed crew/cargo mission, or high-capacity personnel transport can use the same basic machine.

Artificial gravity as part of passenger preparation

The rotating habitat is not limited to one fixed acceleration. A representative outbound profile starts near Earth gravity and then gradually reduces rotational speed during the later cruise so passengers reach approximately 0.38g before Mars arrival. Return missions reverse that progression, gradually rebuilding toward 1g before Earth arrival. Exact medical schedules remain a human-factors design task.

2. Comparison with NASA concept studies

The comparison is architectural, not programmatic: NASA studies use established or evolutionary propulsion technologies, while MEX-1 explores the downstream consequences of the Claim-17 propulsion premise. The useful point is scale. A 120 m, 1,200 t-class nuclear interplanetary vehicle is not outside the historical size of serious Mars studies.

	NASA DRA 5.0 / Copernicus	NASA Project APEX	MEX-1 concept
Crew / people	Six crew in DRA 5.0	Five crew	Mission-configurable; 20 to several hundred, with 500 as a high-capacity example
One-way time	About 180 days outbound in baseline DRA 5.0	About eight months outbound via Venus assist	About 73 days at 1,200 t / 12 kN reference; about 95 days at 2,000 t in the 600-800 MWe screen
Vehicle scale	Multi-element Mars transfer architecture	110 m, about 900 t departing LEO	120 m ring, about 1,200 t nominal; scalable above 2,000 t
Artificial gravity	Not baseline in DRA 5.0	0.5g by spinning vehicle	Variable: about 1g → 0.38g outbound;
Propulsion supply	Large propellant architecture	Nuclear thermal hydrogen proposed	No conventional material reaction mass; nuclear-electric supply

NASA's later 1.9 MWe NEP-chemical Mars study also illustrates the attraction of persistent nuclear-electric spacecraft, but still requires xenon electric propulsion and chemical propulsion. Its published concept includes a 1.9 MWe reactor/power system and about 2,500 m^2 of radiators for a roughly 760-day roundtrip opposition-class mission. MEX-1 deliberately explores a much higher electrical-power class because the proposed propulsion mechanism is intended to convert electrical energy directly into sustained spacecraft momentum without expelling main reaction mass.

References for comparison

1. NASA, *Human Exploration of Mars Design Reference Architecture 5.0*, NTRS 20090012109; follow-on material gives the approximately 180-day crew-transfer benchmark.

2. NASA CR-192056, *Project APEX: Advanced Phobos Exploration*, NTRS 19930008927: 110 m, 900 t, five crew, 0.5g artificial gravity, eight-month outbound trajectory.

3. NASA, *1.9 MWe Nuclear Electric Propulsion-Chemical Propulsion Piloted Mars Opposition Vehicle*, NTRS 20220004673 / 20220007006.

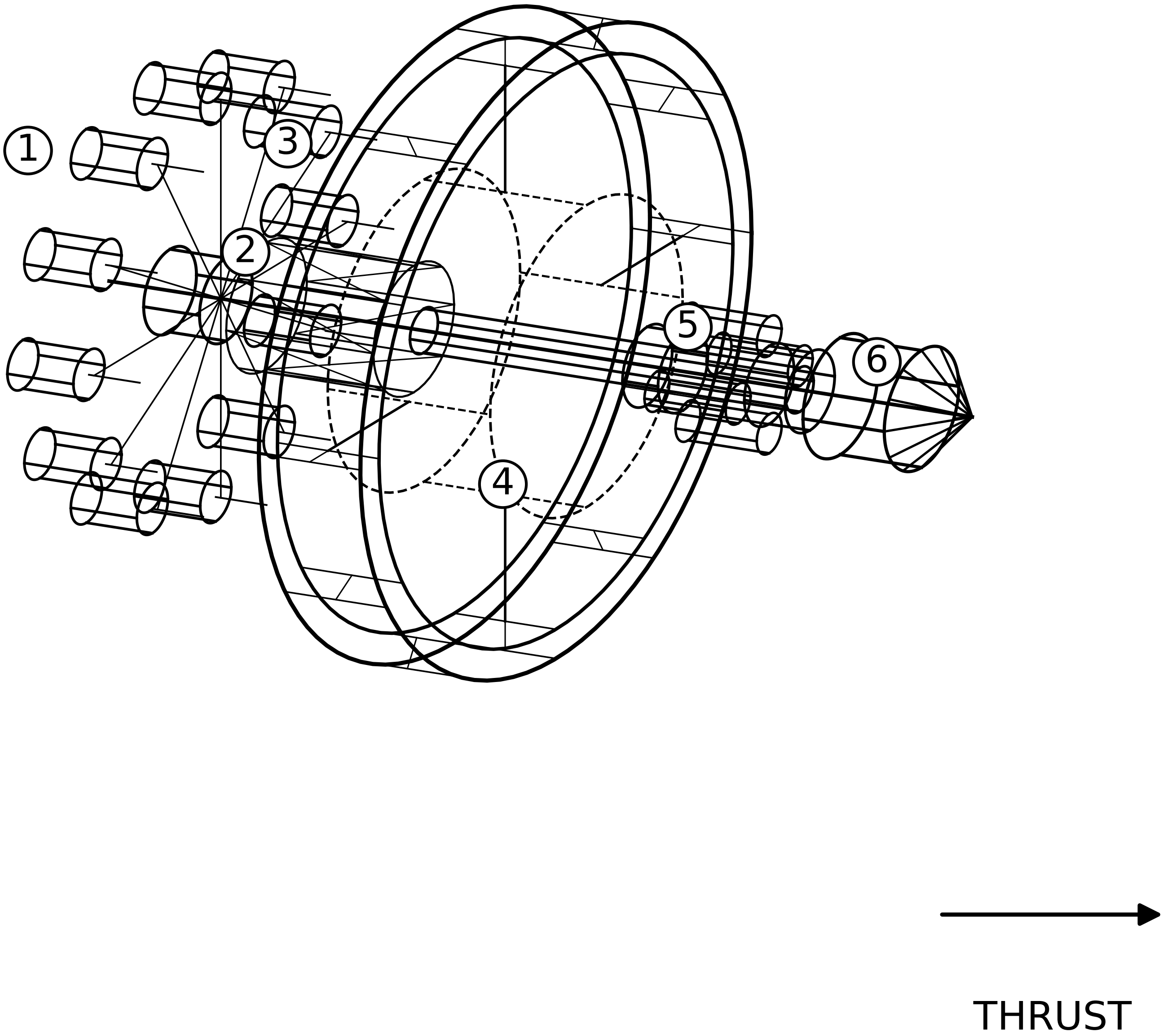
4. Zoran Ozimec, Where Does the Opposite Momentum Go? and Claim-17 Prototype Options; supporting technical material: www.zoran-ozimec.com

Momentum convention. 'No main reaction mass' in this concept means no conventional material propellant is intentionally expelled. Complementary momentum remains accounted in the electromagnetic field/stress system, as developed in *Where Does the Opposite Momentum Go? FINAL.*

3. Architecture: use the radius for gravity and the axis for everything else

The central architectural choice is simple: a large rigid rotating ring supplies artificial gravity, while the spacecraft axis and the broad interior volume enclosed by the ring remain available for cargo, reactors, shielding, service access and propulsion support. The axial dimension is intentionally generous; enlarging the ring in the axial direction adds habitation volume without changing the artificial-gravity radius or rotation law.

Axonometric arrangement

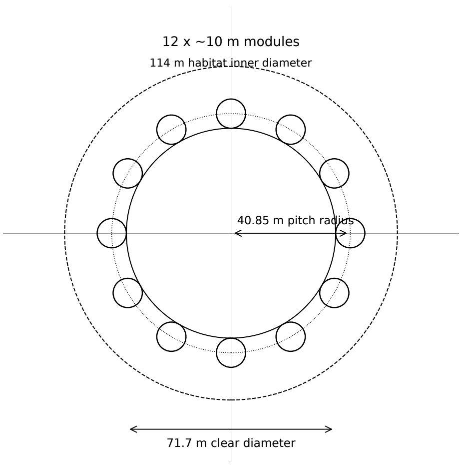


1	12-engine aft propulsion cluster	**2**	RF separation / service zone
3	rotating habitat ring	**4**	low-gravity cargo volume with radial access
5	four-module reactor / power cluster	**6**	command / control

The reference mechanical sequence is: engines aft - RF separation/service zone - inhabited ring surrounding a large cargo volume - reactor/power cluster forward near the axis - command/control forward. The concept deliberately uses axial distance to separate energetic subsystems from the crew while preserving straightforward access from the ring into the low-gravity central cargo region.

At a 60 m habitat radius, rotation varies from about **3.86 rpm at 1g** to about **2.37 rpm at Mars gravity**. A 6 m radial habitat depth and 20 m axial width gives about **45,200 m^3** gross ring volume and about **15,100 m^2** of two-deck floor area. Each additional metre of axial ring width adds about 2,260 m^3 of gross volume.

4. Twelve flight engines: geometry, spacing and optimization



The fixed development reference uses a source diameter near 9.4 m, a target near 9.6 m, axial source-target spacing $d = 2.05$ m, frequency 36.560 MHz, five concentric current contours and 629 conservative local causal segments. The flight study keeps each module in the 10 m class and uses twelve modules symmetrically around the thrust axis.

Flight modules	12 x approximately 10 m envelope
Pitch radius	40.85 m
Clear central diameter	71.7 m
Working axial crew separation	about 40 m, subject to full-wave/RF design
Fixed timing factor	$G = 0.80$ already included in the 1 kN/module screen

A useful low-order cancellation screen uses the five fixed contour radii and the 1 kN development-current vector. The residual coaxial magnetic-dipole-order term is only about 5×10^{-5} of the unsigned contour sum. This is not a full-wave radiation result - the module is electrically large - but it is an encouraging reason to expect less long-range coupling than from one uncompensated loop of comparable size.

Flight power screen

The fixed 1 kN development reference has, per module, about 16.79 MW copper loss and 9.19 MW radiated real power, or 25.975 MW of known real loss inside a 30 MW PSU envelope. Twelve literal development-derived modules therefore give

$$P_{\text{loss},0} = 12(25.975\ \text{MW}) = 311.7\ \text{MW}.$$

Let x be the current-squared throttle fraction, R_F the retained-force factor beyond the already-included $G = 0.80$, and $F_0 = 12$ kN the twelve-module screening force. Then

$$F = xR_F F_0, \qquad P_{\text{loss}} \approx xP_{\text{loss},0}, \qquad P_{\text{mech}} = Fv,$$

so a first bus screen is $P_{\text{bus}} \approx P_{\text{ship}} + P_{\text{loss}} + Fv$. Reserving 50 MWe for spacecraft systems gives:

Installed electric power	Reactor interpretation	1,200 t reference transit	Midpoint speed
400 MWe	4 x 100 MWe	80.6 d	26.0 km/s
600 MWe	4 x 150 MWe	73.6 d	30.5 km/s
800 MWe	4 x 200 MWe	73.2 d	31.6 km/s

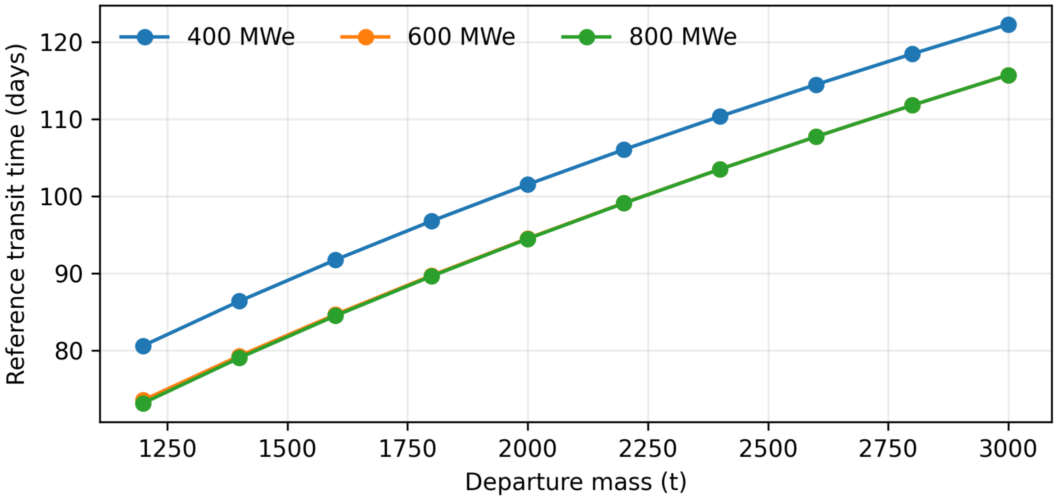
Conductor option. Conventional conductors remain the baseline reference. Superconducting coils may offer a future path to lower resistive loss, but cryogenic support, quench protection, added complexity and reliability penalties make them an optional optimization rather than a requirement.

5. Mission mass is a schedule variable, not a hard stop

For the nominal 12 kN full-thrust case and an illustrative Earth-Mars path length of 100 million km, the symmetric constant-acceleration reference obeys

$$T = \sqrt{\frac{4MD}{F}}, \qquad v_{\text{mid}} = \sqrt{\frac{FD}{M}}.$$

The power-limited results below use the bus model from Section 4, including 311.7 MW of full-current development-reference loss and 50 MWe reserved for ship systems.



This produces the desired operating philosophy. About 1,200 t is a useful fast-transfer reference, not a structural ceiling. A heavily loaded mission above 2,000 t can simply accept a transfer near 95-105 days in the 600-800 MWe range. Even 3,000 t remains in the roughly 116-day class in the same simplified 100-million-km screening trajectory.

Design consequence. The mission planner can trade speed for people or cargo without adding main-propulsion reaction mass. A large increase in payload therefore changes acceleration and schedule rather than forcing a new expendable propulsion architecture.

6. Force robustness, timing margin and steering authority

The fixed module already includes the nominal distributed-path factor $G = 0.80$. The remaining flight uncertainties - real target transfer function, full-wave feeds/returns, mutual array interaction and physical current establishment - should not be hidden inside one arbitrary efficiency. For mission robustness, it is more informative to ask what happens if only a fraction R_F of the twelve-module screening force survives at full current.

Retained force R_F	Net force	Transit time	Midpoint speed	Peak Fv
1.00	12.0 kN	73.2 d	31.6 km/s	379 MW
0.80	9.6 kN	81.8 d	28.3 km/s	272 MW
0.60	7.2 kN	94.5 d	24.5 km/s	176 MW
0.50	6.0 kN	103.5 d	22.4 km/s	134 MW
0.40	4.8 kN	115.7 d	20.0 km/s	96 MW
0.25	3.0 kN	146.4 d	15.8 km/s	47 MW

Steering by differential engine output

The twelve engines are distributed on a pitch radius of about 40.85 m. Intentionally throttling or temporarily disabling selected modules shifts the resultant thrust line and produces pitch/yaw control torque while the remaining engines continue to accelerate the spacecraft. One kilonewton of deliberate thrust imbalance at this radius corresponds to approximately

$$\tau \approx rF = (40.85 \text{ m})(1 \text{ kN}) \approx 40.9 \text{ kN m}.$$

The control law must include the angular momentum and gyroscopic response of the rotating spacecraft. Purely axial differential thrust does not itself generate roll torque, so roll remains a separate attitude-control function.

Timing-error robustness in the reduced model

Around the ideal return phase π, let the actual phase be $\pi + \delta$. Then

$$R_\phi = \frac{1 - \cos(\pi + \delta)}{2} = \frac{1 + \cos\delta}{2} = \cos^2\left(\frac{\delta}{2}\right).$$

Thus a 10° phase error retains about 99.2%, 30° retains 93.3%, 60° retains 75%, and 90° retains 50%.

7. Power system: four modules, variable electrical output, long service life

The reference ship uses four independent reactor/power modules placed near the axis and forward of the inhabited ring. The phrase *modified naval-variant* is used here as a conceptual engineering description: compact, high-power, long-life fission hardware adapted radically for vacuum operation, spacecraft shielding, electric conversion and serviceability. It is not an assertion that an existing naval reactor can be installed unchanged in space.

Configuration	Total electric power	Use in this study	Character
4 x 100 MWe	400 MWe	lower-power screen	longer power-limited acceleration
4 x 150 MWe	600 MWe	strong reference	near-full nominal performance
4 x 200 MWe	800 MWe	high-margin reference	full nominal acceleration with reserve

The 25-year nuclear refueling/core-service target is one of the architecture's defining advantages. Twenty-five years spans about 11.5 conventional 26-month Mars synodic intervals. The ship is therefore conceived as a persistent interplanetary asset whose main propulsion is serviced because its nuclear fuel and hardware eventually require service - not because each Mars flight consumes a stock of main-propulsion reaction mass.

The dominant power-engineering trade: heat rejection

Hundreds of megawatts electric imply a thermal system of the same engineering order. Exact radiator area cannot be fixed without reactor conversion efficiency and radiator temperature, but the scale is first-order. The Stefan-Boltzmann screen

$$A_{\text{rad}} \approx \frac{Q}{\epsilon \sigma T^4}$$

shows why high-temperature conversion and radiators are valuable. At $T = 900$ K and emissivity $\epsilon = 0.9$, each square metre rejects about 33.5 kW radiatively; rejecting 0.5-1.0 GW would therefore require roughly 15,000-30,000 m^2 of effective radiator area. The long axial spacecraft geometry is intentionally compatible with large deployable radiator wings.

During deceleration the spacecraft must also handle removal of kinetic energy. Bidirectional power electronics and regenerative recovery are attractive design goals; otherwise equivalent energy must be rejected as heat or electromagnetic power. This is a system-level design requirement rather than a change to the mission geometry.

8. Engineering handoff: what is now defined and what remains open

The concept study has reached a useful boundary. The spacecraft's mechanical logic is sufficiently defined to hand the next stage to specialist engineering without pretending that detailed spacecraft design is finished.

Defined concept geometry	120 m rotating ring; 6 m radial depth; 20 m baseline axial width; whole reference vehicle rotating; reactors forward near axis; shielded inhabited ring; engines aft; about 40 m RF separation; twelve engines on an approximately 40.85 m pitch radius.
Defined gravity concept	Variable artificial gravity: about 1g after Earth departure, progressively reduced toward 0.38g before Mars arrival; reverse progression on return.
Defined mission philosophy	1,200 t fast reference; mass scalable well above 2,000 t; crew/cargo interchangeable; about 500-person high-capacity example; 25-year nuclear service target; persistent reusable transport.
Defined propulsion screen	Twelve 1 kN-class modules, 12 kN nominal reduced force, fixed internal timing geometry, $G = 0.80$ already included.
Defined power logic	Treat reactor electric power as a mission variable; separate real electrical loss from mechanical power Fv; 400/600/800 MWe form the useful first comparison family.
Defined control logic	Differential throttling or temporary engine disable provides substantial pitch/yaw authority; roll and full rotating-body attitude control remain dedicated engineering tasks.
Next propulsion task	Full-wave twelve-module solution including target $H(\omega)$, feeds/returns, mutual coupling, conductor technology, radiation pattern and structural interaction.
Next nuclear task	Reactor/shield/conversion/radiator mass closure, fault containment, serviceability and crew-dose design.
Next human-systems task	Life support, food/water logistics, medical capability, emergency sheltering, docking/evacuation, passenger/cargo mission mixes and medically appropriate gravity-transition schedules.

Concept-study conclusion. The twelve-engine architecture fits geometrically within a NASA-scale 120 m Mars vehicle while leaving substantial low-gravity cargo volume near the axis. A 1,200 t reference ship gives a roughly 73-day screening transfer at 12 kN; mass above 2,000 t remains compatible with roughly 95-105 day transfers in the 600-800 MWe range. Even the conservative development-reference electrical-loss level does not force an implausible power point. Four modular reactor/power units allow a broad mission family, with 600-800 MWe emerging as a strong first engineering range.

Growth path: from exploration to pre-colonization. The MEX-1 architecture is not limited to exploration missions. Its scalable habitat width, central cargo volume, modular propulsion and long-life nuclear power system allow the same basic vehicle to support early pre-colonization missions. A transport-focused configuration could carry several hundred people together with surface vehicles, construction equipment, food, power systems and settlement infrastructure. Further increases in crew and cargo can be obtained by increasing axial habitat width and accepting the corresponding increase in spacecraft mass and transit time.
Configurations carrying more than 1,000 people are therefore realistic architectural growth options rather than a new propulsion concept. Detailed settlement logistics, surface infrastructure and fleet operations lie beyond the scope of this exploration study.

Scientific dependency. This concept remains conditional on a controlled Claim-17 prototype measuring a nonzero response consistent with *Where Does the Opposite Momentum Go?* and *Claim-17 Prototype Options*. Numerical values remain engineering-screening and mission-trade quantities.