TECHNOLOGY

Hughes advances SDI mini-projectile
WASHINGTON D.C.

A mini-projectile weighing
only 3kg that will intercept a
nuclear warhead in space will
be ground-tested by Hughes,
towards the end of next year,
reports Julian Moxon.
The lightweight exo-
atmospheric advanced pro-
jectile (Leap) is a project to
develop a kinetic-kill vehicle
(a missile that destroys a
target by force of impact
alone) using technologies
beyond those now being devel-
oped for Phase 1 of the Strate-
gic Defence Initiative. If
chosen for development by
the SDI Office, such a vehicle
could be a part of either a
space-based or ground-based
kinetic-kill interception

system.
A Leap mockup exhibited at
a recent SDI symposium in
Washington D.C. provided a
good idea of the impressive
technology advances being
made in SDI research. Leap
demands microminiaturised,
nuclear-hardened electronics,
small but powerful ultra-fast
reaction rocket thrusters (and
the associated valves for high-
speed switching), an advanced
infrared detector, and a
miniature inertial measure-
ment unit.

The pace of development
has surprised even Hughes,
which is also involved in
developing the ground-
launched high endoatmos-
pheric defence interceptor
(Hedi), a larger, ground-
launched kinetic-kill vehicle
designed for late mid-course,
and terminal defence against
incoming warheads.

"At the time we designed
Hedi," a Hughes engineer told
Flight, "we would have
thought the technology
needed for Leap was impos-
sible to achieve in the near
future." The company now
plans to ground-test a proto-
type Leap in November 1989,
and is under pressure from the
SDI Office to bring the project
forward—possibly with a view
to incorporating Leap tech-
nologies into Phase 1 kinetic-
kill-vehicle systems.

Leap was originally
designed to be fired from an
electromagnetic railgun,
hence the need for smallness.
Railgun technology is lagging,
however, so planning now

Leap ftopj is roughly 14in long
and 8in diameter and uses a fibre-
optic gyro f centre) inertial sensor
and focal-plane array infrared
seeker (above). The computer
frightj fits behind the mirror

includes the use of more-
conventional, chemically
fuelled rockets to boost Leap
to the interception area from
the space-based "garage" that
would house a suite of kinetic-
kill vehicles.
A Leap projectile would
close on its target at about
48,000km/hr, placing extreme
demands on the terminal
guidance system. In a space-
based mode, Leap would be
fired from a garage at the
general area of a nuclear
warhead, initial targeting
having been pre-computed by
other SDI sensors. At an
undisclosed range, Leap's own
terminal guidance system
would guide the missile
(known in SDI parlance as a
"smart rock") to a direct hit.

Critical Leap technologies

indentified by Hughes include
the optics necessary to view
the target, the algorithms that
ensure the missile

ignores the target's exhaust
plume and aims instead for
the warhead, and the
computer that controls the
projectile.
The "eye" of the Hughes
system is a staring (as
opposed to a scanning) focal-
plane array containing 16,384
mercury cadium telluride
elements. These collect
infrared emissions focussed
by the parabolic mirror at the
front of the missile, and
convert them to electronic
signals. Hughes claims a
significant advantage over its
rivals in the field, and has
demonstrated a Leap-sized
focal-plane array at its Missile

Systems facility in California.
Video signals from the
focal-plane array, and
location signals from the
inertial measurement unit (a
Litton fibre-optic component
weighing only 6oz) are
processed in a microcomputer
located on both sides of a disc
that fits directly behind the
mirror. Hughes says that
signal processing is carried
out at 4 • 1 million operations a
second, a rate similar to that
found in today's much larger
optically guided missiles.

Hughes has developed and
successfully tested algorithms
that will prevent the missile's
infrared seeker from aiming
for the hot exhaust plume of
the target instead of the cooler
warhead. Accuracy has
already been tested against
simulated solid- and liquid-
fuelled rockets, from all
aspects, says the company.
Guidance commands are
issued to two sets of thrusters,
under development by
Marquart. Located at the e.g.
of the projectile are four larger
bipropellant thrusters (pro-
pellant is stored in tanks
running the length of the
missile) that will translate the
body laterally in any direc-
tion, according to the combi-
nation in which they are oper-
ated. To prevent drift, all four
thrusters would be operating
at once but at varying thrusts,
so that fine control of flight
direction is achieved as the
missile approaches the target.

For attitude control, 12
much smaller (sin-long)
thrusters arranged in four
three-plane sets (for roll,
pitch, and yaw) are located at
the front of the missile, just
behind the computer. With a
response time of around 1-4
millisec, these can be switched
at an extremely high rate to
aim the projectile as it homes
in.

Leap ground testing will
involve hovering the missile
using its thrusters to check
the accuracy of the guidance
system. The present $50-
million, 27-month SDI
contract, awarded at the end
of last year, calls for ground
testing only. There are no
plans for flight testing as yet.
"That depends on whether
we're successful," says
Hughes. "So far, things have
worked out extremely well."

34 FLIGHT INTERNATIONAL, 9 April 1988