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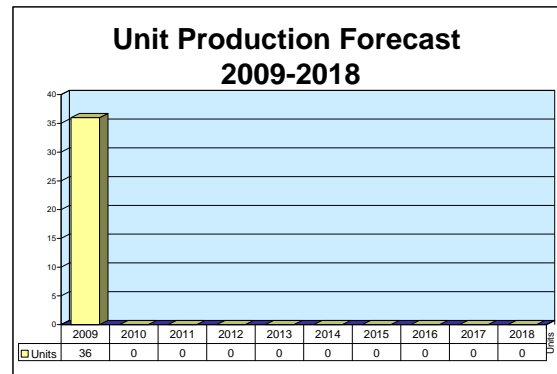
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Bionix

Outlook

- Serial production ongoing for Singapore Armed Forces (SAF) requirement of approximately 400 vehicles
- In October 2006, SAF unveiled the third-generation Bionix Mk II, featuring a networked battle management system
- Production forecast reflects final year of SAF procurement, with no additional sales projected at this time



Orientation

Description. A tracked infantry combat vehicle.

Sponsor. The Republic of Singapore Ministry of Defense, through the Singapore Armed Forces, sponsors the development and SAF procurement of the Bionix.

Licensees. None

Status. Development through serial production.

Total Produced. Through 2008, we estimate ST-Kinetics produced 373 Bionix vehicles, including seven prototypes.

Application. A mechanized infantry combat vehicle, optimized for transporting infantry during offensive and defensive operations.

Price Range. In 2009 U.S. dollars, the Bionix (IFV 25 and IFV 40/50 models) reportedly carries an average unit price of \$1.702 million.

Contractors

Prime

Singapore Technologies Kinetics Ltd	http://www.stengg.com , 5 Portsdown Rd, Singapore, 139296 Singapore, Tel: + 65 6473 6311, Fax: + 65 6471 0662, Email: comms.kinetics@stengg.com , Prime
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Subcontractor

Alliant Techsystems - Armament Systems, Integrated Weapon Systems	http://www.atk.com , 3309 N Reseda Cir, Mesa, AZ 85215 United States, Tel: + 1 (480) 324-8600, Fax: + 1 (480) 324-8758, Email: ammunition.group@atk.com (25mm M242 Bushmaster Cannon)
Detroit Diesel Corp	http://www.detroitdiesel.com , 13400 Outer Dr W, Detroit, MI 48239-4001 United States, Tel: + 1 (313) 592-5000, Fax: + 1 (313) 592-5158, Email: defense@detroitdiesel.com

Bionix

	(6V-92TA Diesel Engine)
General Dynamics Land Systems	http://www.gdls.com, Sterling Heights Complex, 38500 Mound Rd, Sterling Heights, MI 48310-3200 United States, Tel: + 1 (586) 825-4000, Fax: + 1 (586) 825-4013, Email: info@gdls.com (HMPT 500-3EC Automatic Gearbox)
Horstman Defence Systems Ltd	http://www.horstman.co.uk, Locksbrook Rd, Bath, BA1 3EX United Kingdom, Tel: + 44 1225 423111, Fax: + 44 1225 447357, Email: esales@horstman.co.uk (Hydro-pneumatic Suspension System)
MT Aerospace AG	http://www.mt-aerospace.de, Franz-Josef-Strauss-Strasse 5, Augsburg, 86153 Germany, Tel: + 49 821 505 01, Fax: + 49 821 505 1000, Email: PublicRelations@mt.man.de (AVLB 22-Meter MLC 30 Bridge)

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Technical Data

IFV 25

Crew. Three: commander, gunner, and driver. The vehicle can carry seven fully equipped infantrymen.

Armor. Welded steel alloy armor. An additional layer of modular appliqué armor covers most of the hull.

Dimensions. The following data reflect the latest production vehicle. Height is to the top of the weapon mount.

	<u>SI Units</u>	<u>U.S. Units</u>
Length	5.89 m	19.32 ft
Width	2.71 m	8.89 ft
Height	2.59 m	8.49 ft
Combat weight	22.91 tonnes	25.25 tons
Fuel capacity	562 liters	149.47 gal

Performance. The automotive performance reflects use on a paved road.

	<u>SI Units</u>	<u>U.S. Units</u>
Maximum speed	70 kmph	43.5 mph
Maximum range	425 km	263.92 stat mi
Step	60 cm	2.62 ft
Trench	2.0 m	1.97 ft
Slope	30%	30%
Gradient	60%	60%
Fording	1.0 m	3.28 ft

Engine. Detroit Diesel 6V-92TA liquid-cooled diesel engine. This turbocharged powerplant generates 354.2 kilowatts (475 hp), with a power-to-weight ratio of 15.46 kilowatts per tonne (18.81 hp/ton). The 28-volt electrical system features four 12-volt/200-ampere-hour batteries.

Gearbox. General Dynamics Land Systems HMPT 500-3EC automatic gearbox, with three infinitely variable speed/gear ratio ranges.

Suspension and Running Gear. Horstman Defence Systems hydro-pneumatic (hydro-strut)

suspension system, with six dual-tired roadwheels and three track return rollers on each side. The middle return roller supports the whole track; the forward and rear rollers support only the inner half of the track. The drive sprocket mounts to the front. The single-pin cast track features replaceable rubber track shoes/pads.

Armament

Main Armament. Alliant Techsystems 25mm M242 Bushmaster automatic cannon in a fully stabilized mount. For more information on this ordnance, see the "M242 Bushmaster 25mm Cannon" report in Tab D of the *Ordnance & Munitions Forecast*. The vehicle

carries 600 rounds of 25mm ammunition (180 ready, 420 stowed). Elevation, depression, and turret traverse are electrically operated, with manual backup.

Secondary Armament. Two pintle-mounted ST-Kinetics 7.62x51mm NATO (.308 Winchester) general-purpose machine guns. One mounts at the commander's cupola; the other mounts on the roof of the

troop compartment. Three SDS-93 forward-firing, 76mm smoke grenade launchers mount on each side of the turret.

Fire Control. The gunner's position features a standard optical sight and a combined 8x day/thermal sight. The commander's station features an optical relay and display from the gunner's sight. The fire control suite can mount a laser rangefinder, as required.

IFV 40/50

Crew. Three: commander, gunner, and driver. The vehicle can carry nine fully equipped infantrymen.

Armor. Same as Bionix IFV 25.

Dimensions. The following data reflect the latest production standard. Height is to the top of the weapon mount.

	<u>SI Units</u>	<u>U.S. Units</u>
Length	5.89 m	19.32 ft
Width	2.71 m	8.89 ft
Height	2.59 m	8.49 ft
Combat weight	21.51 tonnes	23.71 tons
Fuel capacity	562 liters	149.47 gal

Performance. The automotive performance reflects use on a paved road.

	<u>SI Units</u>	<u>U.S. Units</u>
Maximum speed	70 kmph	43.5 mph
Maximum range	425 km	263.92 stat mi
Step	60 cm	1.97 ft
Trench	2.0 m	6.56 ft
Slope	30%	30%
Gradient	60%	60%
Fording	1.0 m	3.28 ft

Engine. Same as the Bionix IFV 25. The powerplant features a power-to-weight ratio of 16.47 kilowatts per tonne (20.03 hp/ton) in the IFV 40/50 application.

Gearbox. Same as the Bionix IFV 25.

Suspension and Running Gear. Same as the Bionix IFV 25.

Armament

Main Armament. ST-Kinetics 40/50 Twin Weapon Station. This open-top weapons station with side shields mounts a 12.7x99mm (.50 cal) M2HB heavy machine gun and a 40mm CIS 40 AGL automatic grenade

launcher in a stabilized side-by-side configuration. For more information on the grenade launcher, see the "CIS 40 AGL" report in Tab D of the *Ordnance & Munitions Forecast*.

Secondary Armament. One pintle-mounted ST-Kinetics 7.62x51mm NATO (.308 Winchester) general-purpose machine gun on the roof of the troop compartment. Three SDS-93 forward-firing, 76mm smoke grenade launchers mount on each side of the turret.

Fire Control. The gunner employs a standard optical sight to aim the Twin Weapons Station.

Bionix Mk II

Crew. Three: commander, gunner, and driver. The vehicle can carry seven fully equipped infantrymen.

Armor. A modular armor suite, allowing for a range of protection levels, as required.

Dimensions. The following data reflect published data from the contractor. Height is to the top of the turret.

	<u>SI Units</u>	<u>U.S. Units</u>
Length	5.97 m	19.59 ft
Width	2.78 m	9.12 ft

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	<u>SI Units</u>	<u>U.S. Units</u>
Height	2.77 m	9.09 ft
Combat weight	24.8 tonnes	27.3 tons
Fuel capacity	562 liters	149.47 gal

Performance. The automotive performance reflects use on a paved road.

	<u>SI Units</u>	<u>U.S. Units</u>
Maximum speed	70 kmph	43.5 mph
Maximum range	400 km	248.6 stat mi
Step	60 cm	1.97 ft
Trench	2.0 m	6.56 ft
Slope	30%	30%
Gradient	60%	60%
Fording	1.0 m	3.28 ft

Engine. Same as the Bionix IFV 25. The powerplant features a power-to-weight ratio of 14.28 kilowatts per tonne (17.4 hp/ton) in the Bionix Mk II application.

Gearbox. Same as the Bionix IFV 25.

Suspension and Running Gear. Same as the Bionix IFV 25.

Armament

Main Armament. Alliant Techsystems 30mm Bushmaster II/Mark 44 automatic cannon in a fully stabilized mount. For more information on this ordnance, see the "Bushmaster II/Mark 44 30/40mm

Cannon" report in Tab D of the *Ordnance & Munitions Forecast*.

Secondary Armament. One coaxial ST-Kinetics 7.62x51mm NATO (.308 Winchester) general-purpose machine gun; one pintle-mounted ST-Kinetics 7.62x51mm GMPG on the roof of the troop compartment. Three SDS-93 forward-firing, 76mm smoke grenade launchers mount on each side of the turret.

Fire Control. The gunner employs a day/night thermal sighting system to aim the main and coaxial armament.

Variants/Upgrades

Variants. To date, the prime contractor has developed five basic variants of the Bionix design. In addition, two further variants remain on the drawing board.

<u>Designation</u>	<u>Description</u>
IFV 25	Basic Bionix mechanized infantry fighting vehicle.
IFV 40/50	Basic IFV 25, with the Twin Weapon Station and a different troop compartment interior configuration.
Bionix Mk II	Third-generation Bionix IFV, featuring the ATK 30mm Mark 44 Bushmaster main gun (in a two-man turret) and a networked battle management system.
Bionix Armored Recovery Vehicle	Basic IFV 25 chassis, featuring a hydraulically operated boom-type crane and other recovery equipment. First prototype rolled out in 2000; SAF continues to evaluate vehicle.
Bionix AVLB	Armored vehicle-launched bridge. Basic IFV 25 chassis with a MAN Technologie 22-meter (24.06-yd), military-load class 30 bridge.
Armored Command Post	Design proposal for a command post variant, based on the standard Bionix chassis.
Stretched APC	Design proposal for a stretched and widened variant of the basic Bionix IFV.

Modernization and Retrofit Overview. Not applicable at this time.

Program Review

Background. In 1988, the Singapore Armed Forces (SAF) initiated Project Funby to develop an indigenous mechanized infantry combat vehicle. The SAF expected this MICV to augment the existing SAF inventory of some 1,000 M113 armored personnel carriers. Concurrent with this program, the SAF upgraded a portion of its M113 fleet to the more heavily armed Ultra configuration.

Singapore IFV Rolled Out

Following the evaluation of several available MICV designs and the private development of two XV-series prototypes, the Singapore government allocated developmental funding for the fabrication of three testbed vehicles in 1993. The first Singapore IFV prototypes were rolled out in 1994. Following operational tests and the fabrication of an additional preproduction vehicle, the first production vehicles were rolled out in September 1997.

In an April 1997 interview, Singapore's Deputy Secretary of Defense for Technology, Su Guanng, referred to the Singapore infantry fighting vehicle as the Bionix.

In October 2006, the SAF formally unveiled the Bionix Mk II (BXII) vehicle as the third generation of the Bionix vehicle line. The Bionix Mk II exhibits three main features distinct from the earlier Bionix vehicles:

- The ATK 30mm Bushmaster II/Mark 44 automatic cannon as main armament
- An enhanced, modular armor suite
- A battlefield management system (BMS) with a network-centric wireless communication system

Description. Essentially, the three versions of the basic Bionix MICV differ primarily in their armament. The IFV 25 and IFV 40/50 vehicle hull – with its steel armor construction and additional advanced-design stratified-composite armor – offers protection from ballistic fragments and 12.7mm small arms fire. The Bionix Mk II features a modular armor suite, offering enhanced protection and the ability to provide a range of protection levels, as required.

Conventional Layout

The vehicle exhibits a conventional interior layout, with the driver sitting in the left-front of the hull; the powerpack and gearbox mount in the right-front of the hull. The driver's station features a single-piece hatch cover and three day periscopes; the middle periscope is

interchangeable with a passive night vision device. The driver employs a steering wheel for directional control.

Main Armament Options

The IFV 25 fighting compartment consists of an all-welded steel turret with additional appliqué armor. The gunner sits to the right of the 25mm M242 main armament; the commander sits to the left. Both turret crew stations feature single-piece turret hatch covers. Both the commander and gunner can fire the main armament.

The IFV 40/50 Twin Weapons Station mounts the 12.7x99mm (.50 cal) M2 heavy machine gun and 40mm CIS 40 AGL automatic grenade launcher on a common table; the gunner cannot fire the weapons from within the vehicle. Elevation (45°), depression (-8°), and traverse (110° to the left and right of vehicle centerline) are electrically operated, with manual backup. The turret crew of the IFV 40/50 employs three M17 and two L794D periscopes for observation.

Like the IFV 25, the Bionix Mk II fighting compartment consists of an all-welded steel turret with additional appliqué armor. The gunner sits to the right of the 30mm Mark 44 main armament; the commander sits to the left. Both turret crew stations feature single-piece turret hatch covers. Both the commander and gunner can fire the main armament.

The Network-Centric Bionix

The Bionix Mk II represents the third generation of the Bionix family, as well as the first SAF vehicle with a networked capability. Both the Bionix Mk II IFV and the Bionix Mk II armored command post vehicle feature a battlefield management system (BMS) and a network-centric wireless communication system. According to the contractor, this enhanced command and control suite offers the following advantages:

- It provides the SAF with the ability to operate in a network-centric environment.
- It makes the Bionix Mk II the cornerstone of the SAF's 3rd Generation Force, equipping it with the ability to "achieve precision in maneuver, information, and strike."
- It provides SAF soldiers with digitized map planning functions and the ability to share information on friendly and enemy force dispositions.

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- It offers a marked improvement in situational awareness across the entire fighting unit, allowing the battalion headquarters "to command and control its forces more effectively."

Basic Troop Compartment

The troop compartment occupies the rear of the vehicle; a rear power-operated ramp provides primary troop access/egress. The IFV 25 features a single-piece hatch cover in the troop compartment for access to the roof-mounted machine gun; the IFV 40/50 features two

roof-mounted hatch covers. The IFV 25 and the Bionix Mk II provide seating for seven fully equipped infantrymen (three on each side, one to the rear); the IFV 40/50 provides seating for nine (four on each side, one to the rear). The Bionix does not feature firing ports or vision blocks in the troop compartment.

The basic Bionix vehicle does not feature a nuclear, biological and chemical (NBC) protective suite or an air conditioning system, as SAF specifications did not include such amenities. However, ST-Kinetics offers these features as options on export models.

Related News

Get Ready for the Beast – A beast of a vehicle will be unleashed on operations when the U.K. Ministry of Defence converts more than 100 Broncos from Singapore Technologies Kinetics into Warthog armored vehicles for the armed forces in Afghanistan, in a deal that is worth over GBP150 million.

Bronco will arrive in the U.K. in 2009 and will be transformed into the armored, all-terrain vehicle Warthog. Plans are for the Warthog to replace the Viking in Afghanistan. The Warthog will be powered by a 7.2-liter engine producing 350 bhp and will be able to move through water – all while carrying up to 14 troops. When not in the water, the highly agile, all-terrain vehicle will be able to climb steep gradients, cling to severe side slopes, tackle vertical obstacles, and roll across trenches.

Minister for Defence Equipment and Support Quentin Davies said, "Warthog will be true to its name as a beast of a vehicle that can maneuver across difficult terrain, power up steep gradients, and even cling to slopes. Warthog will provide improved protection to our troops in Afghanistan's green zone, where water and a fragile infrastructure make it difficult for other vehicles to operate. It will be able to move through deep water while carrying troops at the heart of our operations."

A protected gun mount, extra armor, specialist electronic counter-measure equipment, and communications tools will be added before Warthog is deployed on operations. Warthog will come in four variants: a troop carrier, an ambulance, a command vehicle, and a repair and recovery vehicle. The ambulance variant will be capable of carrying casualties, medics, and kits. Warthog's repair and recovery variant will be fitted with a crane and winch, and will have the capability of towing another 18-tonne Warthog vehicle back from the front line. (U.K. Ministry of Defence, 12/08)

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Funding

The Singapore Ministry of Defense, through the Singapore Armed Forces, funds the development and SAF procurement of the Bionix vehicle.

Timetable

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Late	1980s	Concept definition
	1991	Initial design development
Early	1993	Initial testbed prototypes rolled out
	1994	Developmental and operational testing
Mar	1997	SAF reveals program
Apr	1997	SAF designates vehicle as the Bionix

<u>Month</u>	<u>Year</u>	<u>Major Development</u>
Sep	1997	First preproduction vehicle rolled out
Oct	2006	SAF officially accepts Bionix Mk II into service
	2009	Serial production ongoing

Worldwide Distribution/Inventories

Export Potential. ST-Kinetics continues to promote the Bionix as a modular system, providing a limited-family-of-vehicles capability. However, the Bionix has yet to score any export sales. Despite the rather "no-frill" configuration of the basic vehicle, the Bionix carries a unit price comparable to that of more sophisticated designs, such as the Turkish armored infantry fighting vehicle and the Italian Dardo. While the Bionix may meet the requirements of its prime customer, the Singapore Armed Forces, it will not make a significant impact on the international market.

Countries. Republic of Singapore (7 prototypes, 366 production vehicles).

Forecast Rationale

Serial production of the Bionix family of vehicles is reportedly in its final year for the Singapore Armed Forces (SAF). Development and operational testing of Bionix variants continue.

In October 2006, the SAF formally unveiled the Bionix Mk II (BXII) vehicle as the third generation of the Bionix vehicle line.

A Family of Vehicles

ST-Kinetics continues to promote the entire Bionix line as a modular system, providing a limited-family-of-vehicles capability.

Enough Bang for the Buck?

While the Bionix has generated some interest on the international market, the steep unit price of the Bionix

places it in direct competition with more sophisticated designs. In a glutted international market, even the enhanced-capability Bionix Mk II simply may not offer sufficient "bang for the buck" to successfully compete with other designs in its price range. We have yet to see evidence that the Bionix family of vehicles has scored its first export sale.

Limited Production Run?

The **Ten-Year Outlook** reflects the final year of the Bionix serial production run for SAF procurement. With an SAF procurement objective of 400 vehicles, we expect ST-Kinetics will likely complete the current Bionix production run by 2010. However, with little prospect for significant export sales, the current run may well mark the extent of new Bionix production.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR UNIT PRODUCTION												
Designation or Program	High Confidence					Good Confidence			Speculative			
	Thru 2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Total
Singapore Technologies Kinetics Ltd												
Bionix IFV 25/Bionix IFV 40/50/Bionix II												
	373	36	0	0	0	0	0	0	0	0	0	36
Total	373	36	0	0	0	0	0	0	0	0	0	36