

DEFTECH VISION 2015

The Defence Future Technologies Foresight program deals with all observable technological trends that might have an impact on the defence landscape. Rather than picking the winners, the program is more about identifying the relevant races that defence and security organisations must address. As civilian investments and developments in technologies have overcome military resources in many research fields, dual-use technologies are become more and more present and important on the battlefield. We offer here a non-exhaustive 360° horizon of these different categories, clusters and technologies.





IDEA Lowest level of technology readiness. Scientific research begins to be translated into applied research and development (R&D). Examples might include paper studies of a technology's basic properties.

TECHNOLOGICAL EVOLUTION

CONCEPT observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions support the assumptions. Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared with the eventual system.



DEFTECH Technology Foresight is a research program





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has been estimated using Envisioning's
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Energy

evices at peak usage.

Propulsion

o as high as 75%

O Storage

and maximizing storage capacity.

gadgets and store energy.

O Transformation

altitude jetstreams.

Y y for being fast and efficient can mean success or failure in the field. esources requiring electricity to operate escalating demands should quiring energy, transmitting energy, and effective use of energy gives loyed assets for their ability to remain self-sufficient and reduce es on unnecessary losses.
gy-Minimizing Idle Listening in Wireless Networks: Reduces the interr p while Wi-Fi isn't in use, resulting in energy savings of about 44%. npatible with 92 percent of mobile devices; but, wireless routers nee ware.
ELLIGENT BUILDINGS Energy intelligent buildings contextually adjustir ivironmental and user activity.
NERGY GENERATION Efforts are being made to produce more efficient . One in particular would use a design that efficiently splits sunlight, loes, into six to eight component wavelengths—each one of which different color of light. Each color would then be dispersed to a cell emiconductor that can absorb it.
ING BATTERIES As battery reliant technology inducts the new generat d Circuits & Power Management IC [PMIC], required by Quick Charge charge 75% faster.
LAR A flexible solar panel built into the back of the vest converts electricity with 30 percent efficiency—a 22 percent improvement ove rry panels now in use by the military. In addition to charging devices, fer electricity from a fully powered device to a dead one and it contai e water-filtration system
ment nergy infrastructure is experiencing vulnerability due to it's highly id outdated methodologies. The systems are vulnerable to cyber-per cks; and, system fluctuations. As the global demands rise for energy, need for dynamic and effective energy management solutions.
JLAR NUCLEAR REACTORS Smaller, factory produced units designed electricity in areas that are isolated or may have smaller electric grids ater and space are limited. SMR energy production can range

O Communications

ommunicative infrastructures can cause catastrophic failures. exponentially; and, it must be transmitted between multitudes There are several methods being explored and built to handle

DEEP WEB Hidden internet through private IP addresses and private sharing networking frameworks; Also Dark Internet networks, which are not accessible via the internet as we know it. In the future this will be of great concern due to advances in encryption / hacking and decryption. Having a separate 'internet' would allow for greater security

SOFTWARE-DEFINED RADIO Software Define Radio (SDR) components historically

5 MOBILE NETWORK Fifth-generation wireless internet connectivity impacts mobile evices and most likely the first implimentations will be in dense urban opulations. Providing the ability to stream a minimum of 1GB/s to multiples of ose devices. Pervasive networks providing ubiquitous computing. The user can multaneously be connected to several wireless access technologies and eamlessly move between them.

OUD COMMUNICATIONS Internet-based voice and data communications ere telecommunications applications, switching and storage are hosted by hird-party outside of the organization using them, and they are accessed over

AERIAL WIRELESS NETWORK Uses drones or a balloon-based designed to partially solve the problem of limited internet access across the globe.

мминісатіоня Free Space Optical (FSO) communications transmit high

















MOLECULAR SENSOR Tiny spectrometer that allows to get instant relevant information about the chemical makeup of materials or physical objects. Social analytics allows for the widespread analysis and influence of population sentiments. Understanding emotional consensus of a group opens the door to not only accurate identification of emotional perspectives surrounding topics, but also the ability to steer the perceptions and opinions of a demographic to, for example, 17 NEUROINFLUENCER The commercial study of neuro imaging techniques to investigate decision making processes; and, use of brain control centers with affective stimuli responses. **PREDICTIVE CRIME PREVENTION** The use of sociometric sensors coupled with neural networked computers to statistically determine the probability of crime (or other anti-social behavior) taking place before it happens. **PROPAGANDA ADVANCEMENT** Sentiment tracking machine learning is modifying social media users content streams, and measuring the effects. **BRAIN-TO-BRAIN INTERFACE** The ability to transmit action to an avatar has been demonstrated; and, reading neural activity is the real science of telepathy.

HUMAN-ROBOTS RELATIONSHIP The human ability to form bonds between oneself and objects is advanced through the mediums of interaction. This includes looks, feel, and also ever increasing empathetic cognitive abilities.

EMOTION HACKING Well-being and peace of mind are seen as curative forms. New technologies are turning our thoughts and emotions, which have been, throughout human history, a black box, into a mathematical, analytical, and trackable thing that can be hacked; making a person calmer or more energized in a few minutes with the use of a headset or longer term through content display.

PERSONALIZED PREDICTIVE ANALYTICS Analytics which get to know the user; and predict behaviors from travel patterns, social interactions, and energy cycles. This leads to personality categorization & assessments of behavior.

O Social

• Monitoring From the hunting plains of the desert thousands of years ago to, the ability to scan uncountable numbers of images digitally, and search through semantic contexts, modern day monitoring systems have transformed from our basic abilities to see and notice things with very large scale acquisition through innumerable means. Surveilance and monitoring provides invaluable information to strategic decisions. SEQUENTIALLY TIMED ALL-OPTICAL MAPPING PHOTOGRAPHY CAMERA 'Motion picture

Social Crowd Gathering information has always been subject to a certain cost and availability. Individuals abilities to connect and coordinate with large groups revolutionizes how quickly ideologies can be spread and actions instigated. The ability to monitor social sentiments has never been so expansive or so inexpensive; and, neither has the ability to manipulate emotions and perspectives.

femtophotography'—is all-optical mapping of the target's time-varying spatial profile onto a burst stream of sequentially timed photographs with spatial and temporal dispersion. (STAMP) VIDEO & IMAGE RECOGNITION Computer Neural Nets and Learning Algorithms are currently able to create accurate sentential representations of images as well as match features of very large data repositories.

BIOHACKING A techno-progressive cultural and intellectual movement which advocates for open access to genetic information and defends the potential of truly democratic technological development. Biohacking can also refer to managing one's own biology using a combination of medical, nutritional and electronic techniques. This may include the use of nootropics and/or cybernetic devices for recording biometric data & enhancing performance. EMPATHIC THINGS Devices of all kinds, shapes and sizes – around, on or inside the pody – that behave increasingly smarter and link up more and more intuitively with mankind's extremely personal and natural interface. **QUANTIFIED SELF** Movement to incorporate technology into data acquisition on daily life in terms of inputs (e.g. food consumed), states (e.g. mood), and performance (mental and physical). With the coming changes in the amount and diversity of datasets, data-centric approaches that compute on massive amounts of data to discover patterns and to make clinically relevant predictions would be increasingly common in translational bioinformatics

Nanotechnology & Materials

O Systems

n the air for vears.

C Logistics

For the last century the sky has been an expansive playground of imagination and opportunity; NGAD, Next Generation Air Dominance, is still on everyone's mind. From SCRAMJets to UAV's and communications logistics. There is increasi amounts of interest in the field as a whole from commercial capitalization to

LONG DISTANCE UAV Unmanned Aerial Vehicles used for long distance monitoring and reconnaissance with increased endurance.

POCKET DRONE Small, fitting easily into the palm of a hand or a pouch pocket. s a fundamentally simple drone: it's a camera that flies, useful for the military as a sneaky scout. The pilot uses a one-handed controller and watches video f

ELAUNCHABLE ABOVE ATMOSPHERE TRANSPORTATION Relaunchable commerci bace flight systems being pioneered by SpaceX and other competitors.

SCRAMJET Chemical reaction engine with no moving parts, using high press airflow for creation of hypersonic propulsion.

HIGH ALTITUDE PLATFORMS A quasi-stationary aircraft that provides means of delivering a service to a large area while staying thousands of feet above

Base Compound Ingoing research in compounds has lead to interesting discoveries in molecular ynthetics with properties that far exceed any conventional and traditional structures'. As there become more and more nodes of research and new-comers o the fields; expect that the influx and cross connections of ideas will spur chaos, **CARBON NANOTUBE** Molecular-scale tubes of graphitic carbon, they are among the stiffest and strongest fibres known. CARBYNE Is a super-material with twice the tensile strength of its predecessor graphene, and three times the tensile stiffness of diamond. **3D MATERIALS** From powders, CLIP liquids, PLA, and multitudes of other choice the options for 3D printing even include Carbon Fiber & Kevlar. AEROGEL A synthetic porous ultralight material derived from a gel, in which the liquid component of the gel has been replaced with a gas. Potential applications include improved thermal insulation, chemical absorber for cleaning up spills, electrochemical supercapacitors and shock absorption. **GRAPHENE** Is the modern go-to material for engineers looking to create all manner of new electronic devices. From ultra-frugal light bulbs, to super-efficient solar cells, flexible displays and much more, graphene is a multitasking marvel. New techniques are also creating 3D objects out of graphene that opens up the possibility of fashioning a whole new range of innovative electronic devices

METAMATERIALS Materials with a precise shape, geometry and arrangement which can affect light and sound in unconventional manners. Potential applications iclude smart solar power management, public safety, improving ultrasonic sensors, and even shielding structures from earthquakes. O Biological lano & micro scale applications of technology are integrating bio-compatibility; Illowing for highly specific and targeted uses. This ranges from new methods for ighting viruses by passing through the Blood Brain Barrier, protein based nolecular machines, to bacteria resistant surfaces. Threats and opportunities **ANTIMICROBIAL NANOCOATINGS** The use of Nanotechnology to create uninhabitable surfaces, or lethal environments for microbes has many applications for health. NANOPHASE TITANIUM ALLOYS Reduction in bacteria and microbial growths for metal use in the medical field, as well as optical property uses. IANO FOOD Engineered particles are already disbursed on food in the form f coatings to preserve the integrity of food and it's color. Nanosilver preserve od from fungi and microbes, and other engineering feats replicate flavor d textures of food. **NANOTECHNOLOGY CAMOUFLAGE** The ability to change or modify our appearance for one reason or another has many applications for society from sexual partner selection to espionage; it also has health aspects relating to radiation protection O Construct

This cluster contains Nanotechnology focused on building at the particulate scale. Assembly and construction technologies from widespread 3D printing, molecular self-assembly and protein chain alteration to the use of passive and inherent energy properties for macro-scale construction, as well as dynamic infrastructural support. **MICROSCALE 3D PRINTING** 3D printing that uses multiple materials to create object such as biological tissue with blood vessels. **4D PRINTING** The manufacture of end-use products using additive manufacturing techniques and materials that are able to change and mutate over time when exposed to water, temperature changes and/or air to self assemble. **CONTROLLED SELF-ASSEMBLY** Machines that manipulate individual atoms with organism-like self-replicating abilities. These bottom-up, atomically precise 3D printers would be able to carefully create sequences of DNA, RNA or protein. **VECTOR CONTROL** Electrostatic delivery of lethal, to mosquito, nanoparticles. NANO-ARCHITECTURE Materials whose structures can be precisely tailored so they are strong yet flexible and extremely light. Lighter structural materials would be more energy-efficient and versatile. NANOFACTORIES A proposed system in which nanomachines would combine reactive molecules via mechanosynthesis to build larger, atomically precise parts. These, in turn, would be assembled by positioning mechanisms of increasing size to build macroscopic (human-scale) products that remain atomically precise. O Devices pable of creating vast improvements to systems of measurement, in packages fraction of the size of their predecessors. Imagine a chemical spectrography lab hich can be carried in a pocket and synced to a super computer, with its data CATHODES FABRICATED FROM NANOMATERIALS Nano structured cathodes have shown higher theoretical capacities compared to conventional cathodes

ov 25% or more. NANO ELECTROMECHANICAL SYSTEMS Devices integrating electrical and mechanical functionality on the nanoscale. NEMS typically integrate transistor-like nanoelectro-nics with mechanical actuators, pumps, or motors, and may thereby form physical, biological, and chemical sensors. NANOELECTRONIC DEVICES These devices are designed on the molecular level taking into account atomic interactions at very close proximities; and, has dynamic materials dependencies while creating non-traditional circuit systems. 143 NANOGENERATOR Converts mechanical/thermal energy as produced by small-scale physical change into electricity. **Materials** Creating properties never before seen in nature, as well as the restructuring of existing materials, are among the most exciting prospects in this cluster. Subtopics from metamaterials with optical plasmonic properties to foam metals, are paving the way for lightspeed computing, subatomic microscopes, self assembling structures with increased durability and light weight hull designs. **BIOMATERIALS** Derived either from nature or synthesized in the laboratory, biomaterials can be used to enhance or replace natural functions in the body. INVISIBILITY CLOAKS A material system which creates an optical illusion showing what is on the other side with enough clarity to effectively hide an bject in plain sight. MORPHING MATERIALS Materials that change shape and return to their initial form.

ANNO GLASS Coatings to composition; nanotechnology is providing hydrophoobic and repellent static functionality; as well we increased optical performances. 148 NANO TEXTILES Nano textiles are providing anti-microbial and hydrophobic features. 49 NANOCOMPOSITE PLASTICS Nanocomposite plastics and polymers have multiple applications from faster biodegradation to increased flame retardancy, and higher structural performances. NANOENGINEERED COPPER Ultraconductive materials with thermal management to apate heat at a higher rate. SELF-HEALING MATERIALS A class of smart materials that have the structurally incorporated ability to repair damage caused by mechanical usage over time. The inspiration comes from biological systems, which have the ability to heal after being wounded. A material (polymers, ceramics, etc.) that can intrinsically correct damage caused by normal usage could lower production costs of a number of different industrial processes through longer part lifetime, reduction of inefficiency over time caused by degradation, as well as prevent costs incurred by material failure **NANOTECHNOLOGY SOLAR CELLS** Efficiency improvements in solar technology through ovative uses of nanotechnology. NEGATIVE INDEX MATERIAL Negative phase velocity & Negative Refraction; perfect lense & optical communications. Negative permeability and negative permittability. AUXETIC MATERIALS When stretched, auxetic materials become thicker perpendicular to the applied force. This occurs due to their hinge-like structures, which flex when stretched. Auxetics may be useful in applications such as body armor, packing material, knee and elbow pads, robust shock absorbing material, and sponge mops. **SUPEROMNIPHOBIC MATERIALS** Inspired by water bugs that float on liquid surfaces, these materials repel both oily and watery fluids. O Reactive

Reactive Reactive Nanotechnology provides new ways of thinking about how objects interact with the environment. Thermal, chemical, and other contextual reactive properties can be programmed as composites in deeper layers of substances. High mechanical strength, energy, and density allow for structure penetrating thermites to disperse as a 'dust' once inside their target, igniting from alternate stimulus; increasing lethality by magnitudes of 500%. COLLOID CAMOUFLAGE Photo-Thermal Camouflage; a material that is reactive the thermal transfer of photons. 57 DESIGNER CARBON Material that can be adjusted to make energy storage devices, solar panels, and potentially carbon capture systems more powerful and efficient. It matters since energy storage breakthroughs are needed for electric vehicles, renewables on the grid, and other clean-tech advances. NANOMATERIAL-BASED PHOTOCATALYST Photo reactive based materials have applications in many areas and are useful for controlling chemical state change on demand. NANOREMEDIATION AND WATER TREATMENT Already acknowledged as being used in 44 worldwide cleanups; nanoparticles must come into contact with the contaminants for a decontamination reaction to occur. Widely used in **SMART & INTERACTIVE TEXTILES** These fibrous structures 'are capable of sensing, actuating, generating & storing power, and communicating.' Clothing based ineractive interfaces which are also able to collect data, and be running largely THERMO-BIMETALS Thermally activated bimetals would allow for panes of glass capable of becoming shades when exposed to the sun, self-regulating energy consumption throughout the day. **GREEN CONCRETE** Cement which acts like a sponge, and stores carbon dioxide.

NANO CATALYSTS Increasing efficiency and control of chemical reactions to change the state of another substance while maintaining no permanent change itself. Nanotechnology extends these capacities with far greater precision and durability.

are covered with a 'skin' that will instigate a shape change.

Robotics O Weapons

making them more lethal.

SELF-GUIDED BULLETS Use tiny sensors and fins to change direction mid flight.

SONIC WEAPONS & LONG-RANGE ACOUSTIC DEVICES Long Range Acoustic Devices (LRAD) use sound and acoustic radio frequencies to cause discomfort, injure, incapacitate, and even kill the subject of it's focus.

ELECTRIC AIRPLANES RECHARGED BY DRONES Drones serving as flying batteries could dock with an electric plane in flight, enabling the first transcontinental electric airplane journey 170 HOVER BIKE Crowd funded then military contracted four blade personel transport vehicle. Complicated activities coordinated with consumption requirements as well as delivery modes can be looked at as flow management and ability between any given types of nodes. Logistical systems are the moving infrastructure which keep **MODULAR HARDWARE** Platforms designed with common interfacing standards that allow hardware to be developed and assembled in modules. Much like software and API interfaces. This allows for customized incremental expansion units, and the bility to replace ovicting features and equiment on a given product (weapon, bot SMART STRUCTURES Structures which are designed to react to environmental context as well as usage patterns; moderating energy use, and even shape for pptimized efficiencies. ацтомомоця vehicles Vehicles capable of sensing their environment and gating on their own. **DELIVERBOTS** Robot vehicle meant to carry cargo, not people. Could range from very small (and light) robots the size of a suitcase to full-sized trucks ready to hau VEHICLE-TO-VEHICLE COMMUNICATION Let's vehicles send information back and fort between one another with enabled infrastructure; for example, traffic lights. Knowing when a light was going to change would allow vehicles to give a little eads-up to their drivers. We'd then know to brake gradually; or, if there was time display might show what speed would be necessary to make it through. PAYLOAD DRONES Relatively cheap drones with advanced sensors and in capabilities are giving farmers new ways to increase yields and reduce of the sense of the mage. Close monitoring of crops could improve water use and pest managem **ROBOTIC MULE** Rough-terrain robot designed to go anywhere Marines and Soldie go on foot, helping carry their load SWARM CAPABLE DRONES Group of drones lead by algorithms that allow them to perform actions as a swarm unity. This will allow for better coordination and possibility of maneuvers -- Algorithm Led Unmanned Vehicle Collaborative Swar Activity with Disparate Units. **TELEPRESENCE ROBOTS** A remote-controlled, wheeled device with a display to enable video chat and videoconferencing, among other purposes. 180 UAV SUPPLY DELIVERY Autonomous delivery of emergency aid; defibrillator equipped drone, and other equipment. From fully autonomous surgical aides to responsive personal assistants. The Precision Robotics field is advancing through improvements in algorithim ptive, robots; able to carry out routine tasks. AGILE ROBOTS Computer scientists have created machines that have the balance and agility to walk and run across rough and uneven terrain, making them far more useful in navigating human environments. MINIBUILDERS Robotic swarm that is able to construct buildings of any size, with high level of efficiency. PERSONAL ROBOTICS Robotic technology products purchased by individual buyers or families and used to educate, entertain, or assist in the home. **ROBONAUTS** Robonauts, human-like robots designed by GM and NASA, had helped before with basic duties at the International Space Station (ISS). Advanced models of these robots (R2) are able to execute more complex activities, including climbing and mobile tasks. Future plans consider even more advanced support, especially in challenging missions like explorations of other planets. **SERVICE ROBOTS** Robots doing human-scale tasks, having sense and manipulate **SOFT ROBOTICS** Researchers are developing a robotic fabric that moves and contracts and is embedded with sensors, an approach that could bring 'active clothing' and a new class of 'soft' robots. ADVANCED NAVIGATION SYSTEMS The Precision Inertial Navigation Systems (PINS) program seeks to use ultra-cold atom interferometers as an alternative to GPS updates. This allows for the development of matter wave interferometry techniques to measure forces acting on matter, including high-precision atomic accelerometers and gyroscopes. Using this technology, this program seeks to develop an inertial navigation system, which would have greater independence from satellite navigation systems susceptible to attacks and interference. Radio's and other coordination techniques may be used as well. BIOROBOTICS Robots that look and act like animals, insects and other living beings. They replicate existing patterns in nature (movement, stealthiness, flight motion, shell structure, joints, etc...) built this way to enhance performance on determined tasks or even to mimetize within the environment. of the spear when it comes to next generation weapons systems. As advancements in these feilds continue, so must the ways we find to defend against them. The Weapons cluster is among the most diverse, as well as hypothetical, with many of the developing categories shockingly futuristic. **INSECT DRONES** The robotic insect can effortlessly infiltrate urban areas, where dense concentrations of buildings and people, along with unpredictable winds and other obstacles make it impractical. ANTIMATTER WEAPON An antimatter weapon is a hypothetical device using antimatter as a power source, a propellant, or an explosive for a weapon. Antimatter weapons are not thought to currently exist due to the cost of production and the limited technology available to produce and contain antimatter in sufficient **AUTOMATIC TARGET RECOGNITION** An algorithmic conclusion of recognition about a specific object or target based upon data inputs from various sensors. DIRECTED ENERGY WEAPON High Power Microwave (HPM) and DEW's emit highly focused energy, transferring that energy to a target to damage it. Potential applications of this technology include anti-personnel weapon systems, potential missile defense system, and the disabling of lightly armored vehicles such as cars, drones, jet skis, and electronic devices such as mobile phones. **ELECTROLASER** An electrolaser is a type of electroshock weapon which is also a directed-energy weapon (DEW). It uses lasers to form an electrically conductive laser-induced plasma channel (LIPC). **ELECTROMAGNETIC RAIL GUN** A railgun is an electrically powered electromagnetic projectile launcher. Railguns are being researched as a weapon with a projectile that would use neither explosives nor propellant, but rather rely on electromagnetic forces to achieve a very high kinetic energy. Railguns can potentially exceed Mach 10, and thus far exceed conventionally delivered munitions in range and destructive force, with the absence of explosives to store and handle as an additional advantage. This technology could also be used to launch satellites and probes into space. Also known as: Hypervelocity Projectile. **ELECTROTHERMAL-CHEMICAL TECHNOLOGY** Electrothermal-chemical (ETC) technology is an attempt to increase accuracy and muzzle energy of future tank, artillery, and close-in weapon system guns by improving the predictability and rate of expansion of propellants inside the barrel. An electrothermal-chemical gun uses a plasma cartridge to ignite and control the ammunition's propellant, using electrical energy to trigger the process. Also known as: Precision Ignition. **EXPLOSIVE REACTIVE ARMOR** Explosive Reactive Armour (ERA) is an add-on armour to push away & destroy incoming missile projectiles. Designed to offer additional protection to tanks against shaped charge warheads of modern anti tank guided missiles. It is a sandwich of explosive and metal plates. When the jet of a shaped charge warhead hits ERA panel, explosive in it detonates. As a result, the plates are accelerated and start moving outward in normal direction. The moving plates and the detonators render the jet ineffective which loses its penetration capability. HIGH-ALTITUDE ELECTROMAGNETIC PULSE A nuclear warhead detonated at or above 100,000 feet creates electromagnetic radiation from the nuclear explosion. At this altitude the nuclear blast is non-lethal, by itself; however, this would be capable of disrupting, damaging, or destroying ANY solid-state electronic system within its line-of-sight, including satellites. **HYPERSONIC MISSILES** HGV, Hypersonic Glide Vehicle, designed to travel five times the speed of sound. Also called skip-glide, and boost-glide; these vehicles travel in the upper atmosphere with great range and speed with unique aerodynamic properties as well as propulsion methods. The initial 1941 concept, called the Silbervogel, is more relevant than ever before.

MODULAR ARMOR New polyethylene ballistic fibers—which could form soft, supple vests that are nonetheless 20 to 30 times stronger than steel—and fine-tuning ceramic armor at the nanoscale to make complementary hard protection. The Army is also making armor more modular, so soldiers can tailor it to individual missions. Resulting in armor which can easily be reconfigured. **NANOENERGETICS** Nanoparticles have more surface area and, therefore, have increased contact with the other chemicals that make up a propellant or explosive. After a reaction is initiated (that is, the explosion is set off), this greater surface area causes a faster reaction rate, which makes for a more powerful explosion. This work could be useful in weapons systems that would utilize greater amounts of energy, making them more lethal