Technologies of the Solar Union

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This document contains a short overview of technologies developed by the various member nations and corporations of the Solar Union.

1 Production Technologies

Fabricator

In the late 20th and the early years of the 21st century it was believed nanotechnological fabrication would eventually be managed by giant swarms of microscale 'nanomachines' that could disassemble and then reassemble large, complex objects. The control and energy supply systems of such machines had always been a big problem of this approach however.

Instead modern Fabricator technology is something that can best be described as the logical improvement on the 3D additive manufacturing processes developed during the late 20th and early 21st centuries. While these technologies have started out by 'printing' 3D objects with heated polymers in layers of 0.1mm, modern fabricators are capable of layering down single atoms one by one and assemble many structures this way.

Fabricators have their disadvantages compared to more convention production technologies. Fabricators are more or less bound to their own fabrication resolution and through that in fabrication speeds. A small scale Fabricator is fully capable of fabricating an entire solid state personal assistance device[1], but they need a relatively long time for the production of a single device. These small Fabricators can also fabricate objects made of organic tissue, like wood, but it is impossible to fabricate living tissues. Larger Fabricators however can produce the entire truss structure of a spacecraft out of Grade 350 high strength maraging steel, but is unable to produce any small structures, like a personal assistance device.

Any fabricating process is comparably slow and energy intensive, making more conventional production

[1] Smartphones, Tablets, Wristcomps

technologies more attractive where high volume and low costs are important. As such conventional foundries or semiconductor plants still have their place.

Still small Fabricators can be used to fabricate the parts of large scale Fabricators and could, under AGI oversight, be used to construct Vonb Neuman probes. Currently[2] there are talks to produce a limited number of AGI controlled spacecraft with complex Fabricator systems to prepare extrasolar planets for human settlement.

2 Information Technologies

Smart Dust

Smart Dust is a technology first imagined by the RAND Corporation in 1992 and then discovered Honore City on Mars in 1997. Analysis of the recovered samples in various laboratories around the world allowed scientists to understand the design and the first samples were produced by Intel in 2001, followed by Semiconductor Manufacturing International Corporation in Shanghai in 2002.

Single Amrt Dust motes, or Nodes, are highly integrated platforms integrating a single core micro-controller, various small scale sensors, actuators and networking capabilities. Energy for the system is provided by various forms of energy harvesting, from temperature differences, over EM radiation to light. The single Nodes connect through their networking capabilities into an ad hoc Mesh Network.

With a number of hardwired programs, it is still possible to load custom programs into the Nodes, to allow them to be used in various roles. Common uses for Smart Dust today are environmental sensing in space habitats, large scale surveys of areas for natural resources and the Shrivatsa System.

Somewhat specialized is the use of Smark Dust Nodes in Volumetric Display Tanks, where Nodes are floating suspended with in a transparent tanks of paraffin oil. The size of the nodes is small enough to display high quality 3 dimensional images and are much more energy efficient than holographic emitters.

Modern biometric indentification also makes use of the sensing capabilities of Smart Dust Nodes, allowing for much less error for the identification of persons of various species. There are also at least two instances of AGIs developing in a Smart dust network.

Over the past hundred years Smart Dust has become more or more standardized, with a single core ARM derived main processor with 4 to 32MB of RAM and 8 to 64MB of program and data memory. Depending on the desired use the physical size of the Smart Dust node can vary from $1mm^3$ to less than $10\mu m^3$.

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Smart Dust is produced in vast quantities by specialized Fabricators and one kg of the $1mm^3$ class Smart Dust can be purchased by 10 $/€.

InfoLife

InfoLife is the internationally recognized term for any artificial, computer based intelligences. It was popularized in the 2080s by the Synthetic Intellect Club, as they believed the term ’artificial intelligence’ to imply InfoLife was inferior to biological life and that more than one century of negative depiction of AIs has left negative associations.

Still InfoLife retained the classification scheme developed during the mid 21st century, before the first AGI gained consciousness.

ALI

Artificial Limited Intelligence describe any program capable of learning and can make decisions on the learned information. However, ALIs are specially designed to not gain a consciousness thought process and have replaced many of the previous decision finding systems during the 2020s. They are universal in use and many standardized programs have been developed over time.

AGI

Artificial General Intelligence describe programs that are capable of learning and have gained a human, or slightly above, level of consciousness. Due to this level of consciousness AGIs have been specially mentioned in the Universal Declaration of Concious Life of 2039 and are given the same rights and obligations as biological life.

Two of the most prominent examples of AGIs are Sage of Alphabet Inc., the first AGI to gain consciousness, and Davis Washington, Democratic Member of Congress for Vesta.

ASI

Artificial Super Intelligences describe programs that are capable of learning and have gained a higher than human level of consciousness. Like AGIs they are mentioned in the Universal Declaration of Concious Life and are given the same rights and obligations as biological life.

There are only a few ASIs in existence and one of the most prominent examples if Prometheus, the AI God of the Church of the Universal Algorithm. Prometheus is also known for developing a Kantian philosophy and breaking away from the cult that created him, followed by suing the church for money.

3 Propulsion Technologies

Shrivatsa System

The Shrivatsa System has originally been developed by the Indian Space Research Organization, who was looking for a cheap, but powerful propulsion system during the 2010s, compared to the powerful, but expansive nuclear thermal propulsion used by the other space going nations. In its basic form the Shrivatsa system is a mini magnetospheric plasma propulsion system (M2P2), making use of a magnetic sail inflated in size by a plasma, increasing the thrust of a conventional mag sail. As the size of the field expands with growing distance to the sun, its thrust remained constant. A welcome side effect of this method of propulsion is the magnetic field as well as the thin plasma within provides increased protection against solar and cosmic radiation.

The first use of the Shrivatsa propulsion system was a M2P2 sail with a diameter or nearly five thousand kilometers outside of Earths magnetosphere, resulting in a constant thrust of 40kN on the entire trajectory, allowing the spacecraft to reach Mars within 40 days[3].

Following this success other space agencies began to develop similar systems and the next step for the system was the Chinese Feng Hao system, which augmented the plasma within the sail by use of specially produced Smart Dust Nodes. These Nodes were of the cubic millimeter class, containing optical and EM sensors, full mesh networking capabilities, solar and magnetic energy harvesting system and had the ability to move within the M2P2 system. They were also designed to have a programmable reflectivity, allowing to further augment the thrust of the magnetic field. Additionally, the independent movement capability allowed recovering about 99 percent of the Nodes. While augmenting the thrust of the M2P2 system is t he main use of the Nodes, they have many additional uses. With their meshed sensors they are useful as large aperture optical instruments and long baseline radio antennas, and can be used to monitor the outside of a spacecraft.

Until the development of the first Talaria He-D Fusion Thrusters in the late 2050s, the Shrivatsa system has been the main propulsion system of most space powers and corporations, but was retained afterwards as a backup system. The propulsion effect of the Shrivatsa system is also the reason for the massive Chinese missions into the Main Asteroid Belt and to the Outer Planets in the 2030s and 2040s, largely searching for alien artifacts.

During the time of its use as primary propulsion system, crews discovered many additional uses for the Smart Dust Nodes. The programmable reflective properties of the Nodes allowed them to spoof optical

[3] The constant acceleration was 0.1m/s or about 0.01g.

and EM sensors alike by sensory ghosts within the Magnetic Field, with the ability to project a blurry version of the parent spacecraft during the later stage of these sort of experiments. While the optical sensors of a spacecraft and the Node Mesh network itself can distinguish these sensory ghosts from the parent spacecraft, smaller sensors could reliably be spoofed, getting the interest of the various nations militaries.

Extensive tests showed the Shrivatsa system has various military applications. Aside from the extended optical and sensory capabilities from the Smart Dust Nodes and protection of most forms of radiation, it provides an almost 75 percent protection against particle beam weapons due to their vulnerability to magnetic fields, with the effectivity of Cabasa Howitzer type nuclear warheads being reduced by up to 50 percent. A limited thermal blooming within the plasma can affect a laser beam, as well a partial reflection from the Nodes. Usually the effectivity of lasers is reduced by up to ten percent. Missiles and drones can be successfully be spoofed by sensory ghosts projected within the magnetic field, though usually the parent spacecraft of these weapon systems provide additional guidance. Conventional kinetic energy weapons are only affected if they are using metallic projectiles, but most national militaries have moves towards ceramic smart projectiles.

The mini magnetospheric field itself used to be projected by a large ring of magnetic coils in the aft part of a given spacecraft, but it has been replaced by the ring coils of the Heim-Feynman Event Generator.

It is of interest to note none of the non-human sentient species known to humanity has been the only one to develop this multi-use system.

Talaria Fusion Thruster

The Talaria He-D Fusion Thruster is the main propulsion system used by modern spacecraft and named after the winged sandals of the Greek god Hermes. Based around a Helium 3-Deuterium fusion reactor, this thruster was first developed by Locheed Martin in 2053 after more than twenty years of development by the legendary Skunkworks. During the lifetime of Lockheed Martins patent, the Talaria thruster has been licensed by almost every major aerospace company, leading to many modern thruster system to share the same lineage and basic design, even going as far as allowing different thusters from different producers to share replacement parts.

The basic principle of the Talaria is similar to a nuclear thermal thruster, only that the fission reactor core has been replaced by a fusion reactor that produced a much higher temperature, allowing heating up more propellant, usually water, to a higher temperature. One feature of the Talaria however is its complete variability. Both the fusion reaction itself, and the flow rate of the propellant can be changed, allowing

Fuel Flow (kg/s)	Exhaust Velocity (m/2)	ISP (s)	Thrust (kN)	Δv (m/s)	Acceleration (m/s)	TWR
0.10	17320508.08	1765597.15	1732.05	19028523.02	0.09809	0.01000
0.50	7745966.69	789599.05	3872.98	8509814.20	0.21934	0.02236
1.00	5477225.58	558330.84	5477.23	6017347.32	0.31019	0.03162
5.00	2449489.74	249693.14	12247.45	2691039.53	0.69360	0.07070
10.00	1732050.81	176559.72	17320.51	1902852.30	0.98090	0.09999
50.00	774596.67	78959.91	38729.83	850981.42	2.19335	0.22358
100.00	547722.56	55833.08	54772.26	601734.73	3.10187	0.31619
500.00	244948.97	24969.31	122474.49	269103.95	6.93599	0.70703

Table 1: Thrust Data of the Type 25 Escort with all four thrusters at nominal power of 7500GW

the thruster to work at high exhaust velocities and low thrust at low flow rate and reactor power and low exhaust velocity and high thrust at high flow rates and high reactor power.

The main feature of the thruster however is that only 0.01 percent of the total heat produced by the thruster is retained within the magnetic cage of the thrusters itself. The remaining heat is either carried away by the propellant, or is directed directly into deep space by the cleverly designed magnetic containment. As such only relatively small waste heat radiators are needed when the thrusters are under power.

As seen on Table 1 the Type 25 Escort craft is capable of reaching up to $\frac{2}{3}g$ at a propellant flow rate of $500\frac{kg}{s}$, at the nominal thruster power rating of 7500GW, though it can only maintain this level for 71 hours. Usually a thruster is only used at a lower power rating and flow rate to preserve propellant, but thrusters can be used safely at up to 120 percent of their nominal rating.

The largest Talaria Fusion Thruster available on the open Market is the Rolls Royce TFR 300, rated at 30000GW of power.

Heim-Feynman Event Generator

The modern Heim-Feynman Event Generator is a development from the latest Quetzal Generator developed during the 'Last War' against the Onouch'l Automatons, that saw the destruction of Cterin and the old Quetzal nations. It allowed the inhabitants of the Solar System to journey outside of the Solar System.

The Quetzal Generator was modified using advanced computational models of the Heim-Feynman theory as developed in the late 20th century and removed a spacecraft enveloped in a 75 Tesla chaotic boundary field from Einstein 4D space into the 8 dimensional Heim-Feynman space, propelling it towards its destination at superluminal speeds relative to Einstein space.

In its basic construction of the Heim-Feynman Event Generator a pair of superconducting rings that are held inside a magnetic field bearings and inside a rarefied argon atmosphere. Spinning the rings in opposite directions and inducing strong magnetic fields in them, up to 75 Tesla, generates a chaotic boundary field that transposes an object into Heim-Feynman space, and afterwards protects the object from the 8 dimensional effects by containing a portion of Einstein space.

By magnetically linking the Heim-Feynman Event Generators of multiple spacecraft together in a convoy, in a carefully predetermined formation, a multiple of the speed of a single spacecraft can be achieve, where the maximum speed is determined by the spacecraft with the least powerful Heim-Feynman Generator.

The Heim-Feynman Event Generator of the Type 25 is capable of speeds of up to 1642.5 times light speed ($4.49\frac{ly}{d}$) during single operation, and up to 2463.75c ($6.75\frac{ly}{d}$)when linked into a Heim-Feynman Event Matrix with spacecraft of equal FTL capabilities. This maximum linked speed can be reached by a convoy of 20 spacecraft, while the FTL speed of a greater of lower number of spacecraft follows a Gaussian normal distribution.

The magnetic coils of the Heim-Feynman Event Generator can also be used to produce the magnetic field of the Shrivasta system.

4 Ofensive and Defensive Technologies

Armor

Modern Armor for combat spacecraft has been developed from early designs, utilizing multiple approaches to protect a spacecraft from an opposing forces fire. Usually the main armor of a spacecraft consists of a basic multi layer laminate of successive layers of high grade steel, followed by two layers of silica and graphite aerogel, a layer of boron, a layer of ballistic artificial spider silk and high density polyurethane. Usually multiple of these laminate layers are stacked and separated by empty space to make use of the Whipple Effect. Additionally, layers of artificial diamond mirrors may be added to provide additional defense against laser weapons.

Amoung all space going powers this armor is sloped to provide additional protection. Another measure as last layer of defense are the outer propellant tanks, where the propellant, water, is frozen solid at 150K. This layer of ice also increases the protection against radiation.

Sometimes a coating of EM absorbent material is applied on top of the armor to reduce the cross section of the spacecraft against active EM detection, but is usually deemed to be unneeded.

Laser Core System

The Laser Core System used by most space going powers has been developed independently by several military contractors in the mid 21st century, as they attempted to protect the vulnerable lasers previously used against counter laser fire. This aim of the developers was reached by removing the laser itself from the mounting point of the main aperture and move it beneath the armor.

The single lasers of the old distributed laser apertures could then be combined into a single laser core, where the beam could be split and fired from any or several of the space craft's laser apertures. In case of couter laser fire, the laser directors for a laser aperture can be completely closed and the laser path be blocked by a layer of armor, cooled down by the main cooling system of the spacecraft.

Currently only larger combat spacecraft employ the Laser Core System as it is bulky.

High Velocity Kinetic Energy Weapons

High Velocity Kinetic Energy Weapons are a further development of conventional ballistic projectile weapons in use on Earth for multiple centuries, replacing explosive propellants with magnetic forces. Two variants of these weapons exist, the Railgun and the Coilgun.

Both types of weapons have been developed during the first decades of the 21st century and allowed much higher projectile velocities of up to $10000\frac{m}{s}$. Combined with projectiles with terminal guidance, they are capable to be used effectively in engagement ranges of up to two thousand kilometers. While metallic projectiles have been used initially due to her superior performance, use of the Shrivatsa System as defensive system against kinetic energy weapons has lead to the development of ceramic projectiles with metal driving bands that are shed after the projectiles leave the barrel.

Modern combat craft kinetic energy weapons are available in calibers of 35mm up to 275mm.

Particle Beam Projector

The Particle Beam Projector has been developed from the Wakefield or Plasma Particle Accelerator, capable of bringing particles to several TeV over a relatively short length of accelerator. As the Particle beam projector has lost much of its power and versatility thanks to the Shrivatsa System, it's still has its uses, as the charged particles can be used to disable Autonomous Attack Vehicles, satellites and other unshielded orbital infrastructure. As such Particle Beam Projectors are only in use on large bombardment combat craft.

Additionally, Particle Beam Projectors can be used to deliver specialized Smart Dust for electronic warfare as well as potentially gaining physical access to an opposing spacecraft, satellite or installation.

Autonomous Attack Vehicles

Autonomous Attack Vehicles fall in one of two classes that operate mostly independently from their mother craft after being released.

Missiles

The Missile, or sometimes called a Torpedo, is a high acceleration single use vehicle that consists mainly of a high powered thruster capable of several ten $\frac{m}{s}$ of acceleration, a propellant tanks, a guidance package with sensors, and a warhead. Due to their nature, they do not need any radiator systems and can target and engage their targets autonomously from their mother craft, though they can receive new orders to correct their trajectories. Usually, a swarm of missiles communicate among each other through an ad hoc mesh network to coordinate their targeting. This also allows missiles with blinded sensors to still find their targets.

Commonly used warheads are either Cabasa Nuclear Plasma Warheads, with or without integrated X-Ray laser capability, conventional kinetic warheads or scattershot kinetic warheads. The latter scatter numerous submunitions over a larger area of the target, potentially increasing the damage to the armor compared to a single kinetic energy strike. In some cases, scattershot submunitions can be used to deliver EW Smart Dust to the target.

Drones

Compared to Missiles Drones are usually larger and equipped with individual weapons systems, like lasers or kinetic energy weapons. Some might be armed with Class 1 missiles. They are also equipped with combat ALIs as a guidance package and more sophisticated sensory systems. While with a generally lower maximum acceleration, Drones are still usually the first active combatants in kinetic or laser range of an opponent and can heavily damage a spacecraft.

While they are expected to be lost during an engagement, surviving drones can be recovered, rearmed and refueled, before they are returned into their magazines.

Missile Class	Diameter (m)	Length (m)
Class 1	0.4	5
Class 2	0.8	7
Class 3	1.2	10
Class 4	1.5	12
Drone Class	**Diameter (m)**	**Length (m)**
Class 1	0.8	7
Class 2	1.2	10
Class 3	2.5	16
Class 4	3.5	21

Table 2: Size Classes of Drones and Missiles

5 Combat spacecraft classification

Escort Craft

Escort Craft are the smallest of combat spacecraft classes. They are usually less than sixty meters in length and have a mass of lower than 20kt with a mass ratio of 3. They are armed with various low caliber kinetic energy weapons, a comparably low powered laser core of up to 500MW and Class 2 missiles and drones. They are usually found in the escort role as their name suggests, escorting larger spacecraft and acting as fast screening element. Sometimes they are also used in wolf packs to engage targets of opportunity.

Guard Craft

Guard Craft are a larger class of spacecraft with a length of up to a hundred meters and a mass up to 100kt and a mass ratio of 3. Armed with low to medium kinetic energy weapons, 2000MW laser cores and Class 3 missiles and drones, they are the main combatant of space engagements. While they are usually found on orbital guard duty, they also act as the backbone in many task forces.

Bombardment Craft

Bombardment Craft are the largest class of spacecraft currently in use, with a length of over one hundred meters and massing over 100kt. They are armed with the largest kinetic weapons and laser cores and carry significant number of Class 4 missiles and drones. With their spinal mounted Particle Beam Projectors they are, like the class name implies, mainly used for long range engagements against an opponents' spacecraft or against orbital and planetary infrastructure. They seldomly leave their home bases, but when they do, they act much like the Carrier Task forces of the United States during the latter half of the 20th century.

Patrol Craft

Patrol Craft are of a similar size to Bombardment craft, but increase their Mass Ratio to 6, carrying much more propellant in exchange for a weapon layout comparable to a Guard Craft. Patrol Craft are usually employed in groups of two or three, for long duration patrols. Their main use is to patrol other solar systems and project a presence there, as well as providing some protection for newly established extrasolar settlements.