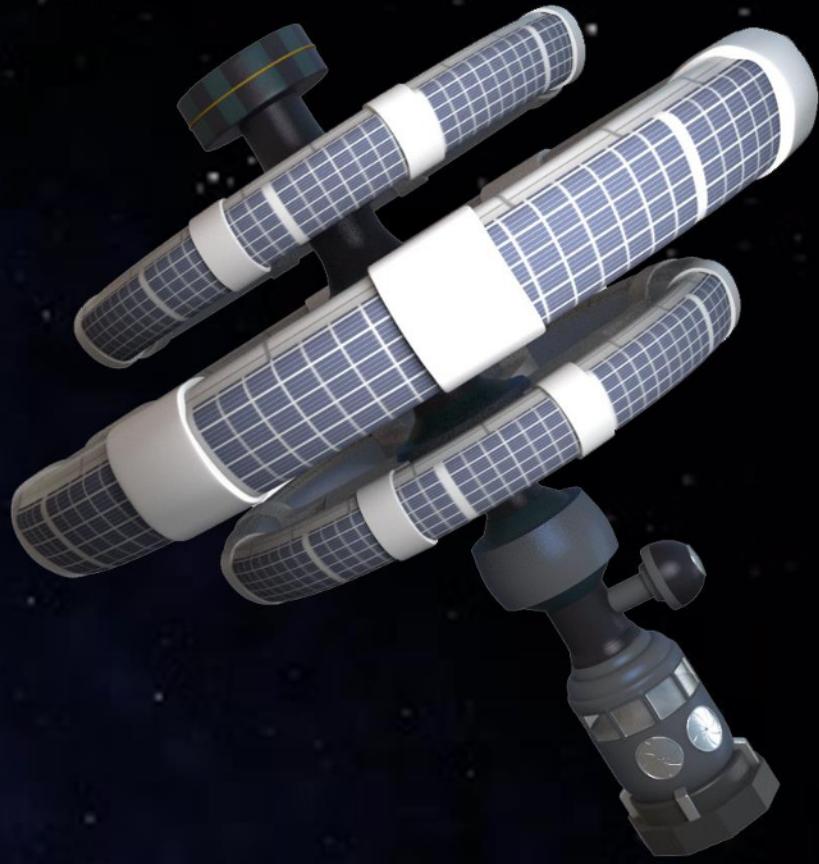


2017

# INGRESS



**NASA Ames Space  
Settlement Contest**

# INGRESS

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# **INGRESS**

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## **1. ACKNOWLEDGEMENTS**

Every single thing in this world, from microorganisms to huge creatures, supports each other to balance the life entity that we know as the Earth. We would like to thank all of these creatures because they are the reason that we are in a position to design this project. Firstly, we would like to express our gratitude to NASA, ISS and AI Globus for giving us this wonderful opportunity to participate in this contest which enabled us to gain a lot of knowledge. Secondly, we would like to thank our parents and friends, along with our Principal, Mrs. MADHURI REDDY madam for filling us with the willpower and motivating us throughout the project. We would also like to specially thank our Mentor Mr. SYED SHAHEN sir for guiding us towards the completion of the project within the limited time frame.

## **TEAM MEMBERS:**

1. T. Guru Sai Sreesh - 9th Grade (Team Leader)
2. B. Vamshi Krishna - 9<sup>th</sup> Grade
3. P. Hari Kiran - 9<sup>th</sup> Grade

# INGRESS

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## 2. INTRODUCTION

### 2.1 EXECUTIVE SUMMARY:

The earth is an enormous place. Creatures known as human beings have started growing on earth. They have been gaining knowledge and discovering new things from the beginning. From the ancient period to the modern period, the population of humans has increased rapidly and it will continue to increase. But there is a limit for everything. Sooner or later, the earth would not be able to bear the growing population of humans. If the humans need to survive, they have to discover new places and colonize them.

*"This is the goal: to make available for life every place where life is possible. To make inhabitable all worlds as yet uninhabitable, and all life purposeful."*

- Herman Oberth, Man into Space, 1957.

Our current mission is to colonize the space. To achieve this goal, we have introduced "INGRESS".

Project INGRESS is all about a space settlement for 12,760 people. It is situated in the Low Earth Orbit (LEO) with an altitude of 800 KM above the equator. The settlement is a small space colony which can hold more than 25,000 people. INGRESS would use advanced and outstanding technology in order to keep the residents comfortable and to run the settlement in an efficient way. The settlement is composed of the residential torus, the agricultural torus, the industrial torus, the central rod, the communication centre, the docking port along with 4 segments. The residential structure and the industrial structure have been named as the HYBRID torus due to its design. The agricultural structure is a truncated torus built for better agricultural facilities. The residential torus is where the residents of INGRESS live in; it is huge enough to hold more than 25,000 humans comfortably. The industrial torus is where different kinds of industries would be constructed. The agricultural torus is where the food production along with production of other raw material takes place. The central rod is the connector of all the major components of INGRESS. The docking station would be used to park space vehicles, in other words the docking station is the entrance and exit for the settlement. The communication centre is built on the top of the settlement as it would play a major role; the placement of the communication centre is beneficial because it enables us to communicate easily using x-rays. The 4 segments which would be constructed around the central rod will be used for different activities such as recreational activities, research, controlling the settlement etc. Solar panels will be placed on the tori to obtain electricity through solar energy. The structure will be built with rigid materials to safe guard INGRESS. The project includes the construction of a base on the moon which would allow us to perform activities such as extracting minerals from the moon etc. The settlement would also use the help of mechanisms which were never introduced before. INGRESS would provide an environment which is better than the earth for people to live in using different methods like creating pseudo gravity. The society of INGRESS will be very unique and formed in a way the residents can spend the rest of their lives in a paradise. We have two additional objectives; one of them is to clean space junk and keep the space clean for our future generations while the other objective is to extract many minerals from asteroids and make them profit. As we go deep into the project, we would discover many other interesting things.

# INGRESS

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## 2.2 WHY INGRESS?

*"All achievements, all earned riches, have their beginning in an idea."*

-Napoleon hill

Every single thing starts with a beginning. Humans have gone through many ages such as the Stone Age, the Bronze Age and the Iron Age, but this is the time to enter a new age; 'The Space Age'. This age will begin by colonizing the space, and INGRESS will act as the first step in colonizing space.

## Ingress : Begining

(Late Middle English)

The reason we chose this name is because it would be the first space settlement built to create a new civilization. INGRESS will be a building block in creating a new generation. We wanted to create a new era filled with joy and prosperity. People of INGRESS would be the creators of a new generation, they would discover new places in the space and start colonizing them and expanding their population. Our settlement would be marked as the beginning of this new era.

This is the reason why we were inspired to choose the name "INGRESS".

# INGRESS

## 3. LOCATION

### 3.1 PLACEMENT:

*“The Earth is the cradle of Humanity. But one doesn’t always live in the cradle.”*

-Konstantin Tsiolkovsky

Before we build our space colony, we have to choose a location to construct it. As we are trying to build a space colony, places like planets or moons are not suitable for it. Once decided that the settlement will be established in outer space itself and not in any planetary or lunar surface. The next step would be determining exactly where in space to place it. Therefore, the space colony has to be located in a predicated and stable orbit that can allow the objectives of the project to be met. Although the colony is a space project, it should need the help of the earth, at least in its initial stages. We have decided that the settlement needs to be constructed in the earth's surrounding's, but we can also rely on a lunar surface "The Moon". Therefore, we can conclude that the settlement, needs to be developed within the Earth-moon system

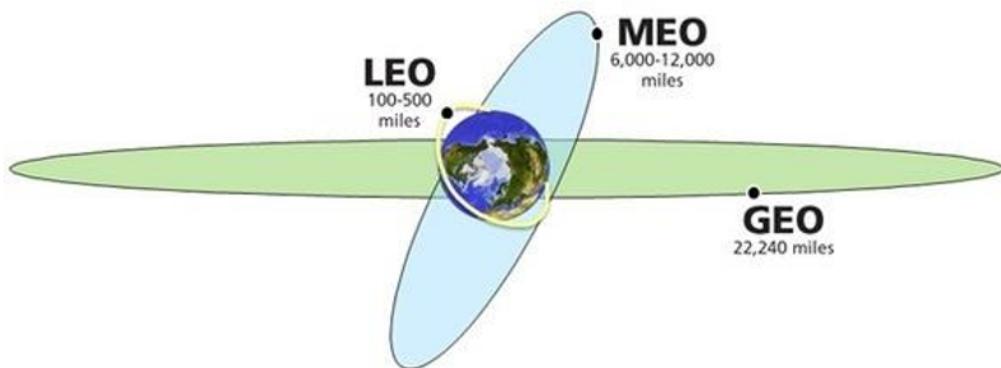


Figure 1. The Low Earth Orbit (LEO), Medium Earth Orbit (MEO) and the High Earth Orbit (HEO).

### 3.2 ORBIT

Now that we have some knowledge about the location of the project, choosing an orbit is a complex task. The project will be located in the geocentric orbit (or) earth orbit (i.e. involving any object orbiting the earth). The settlement would be constructed near the equatorial region. The INGRESS space settlement would be constructed in the equatorial region of Low Earth Orbit (LEO) approximately 800km in altitude. The decision comes after a little orbital research. This orbit would be the best for us due to its accessibility and communication facilities as well as radiation shielding. As the Radiation powers above the van Allen belts are so high that they need a very complex radiation shielding methods, we have chosen a level below the belt which would be financially beneficial. This is really concerning because radiation shields above the van Allen belt would occupy more than 80% of the settlements mass. The radiation shielding is not a small task; therefore, we have chosen this orbit which is within the protection of the Earth's magnetic belt which helps us to deflect most of the radiation. The settlement orbits the earth at a speed of

## INGRESS

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22.334 km/s approximately, with an orbital period of 225.15 seconds. The calculation's can be done by the given formulae

$$V^2R=GM$$

$$4\pi^2R^3=T^2GM$$

Where:

R = Radius of the orbit (800km)

T = Orbital period is seconds

V = Orbital speed in m/s

G = Gravitational constant= 6.673E-11 N.m<sup>2</sup>/kg<sup>2</sup>

M = Mass of earth= 5.98E24kg

# INGRESS

## 4. STRUCTURAL OVERVIEW

### 4.1 STRUCTURAL INTRODUCTION

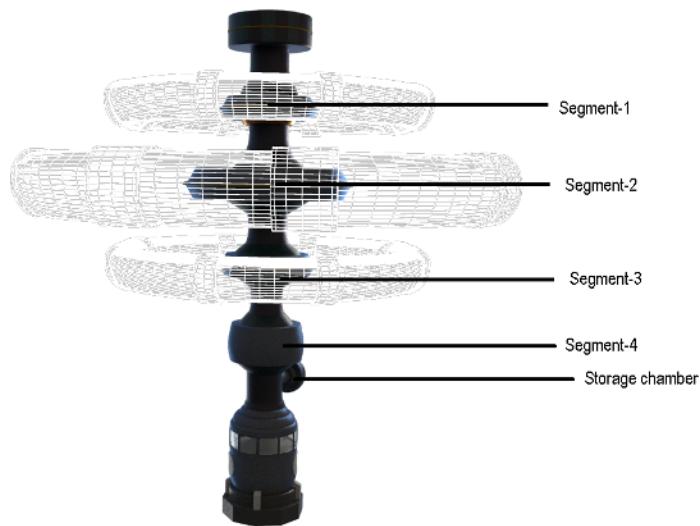


Figure 2 . The structure

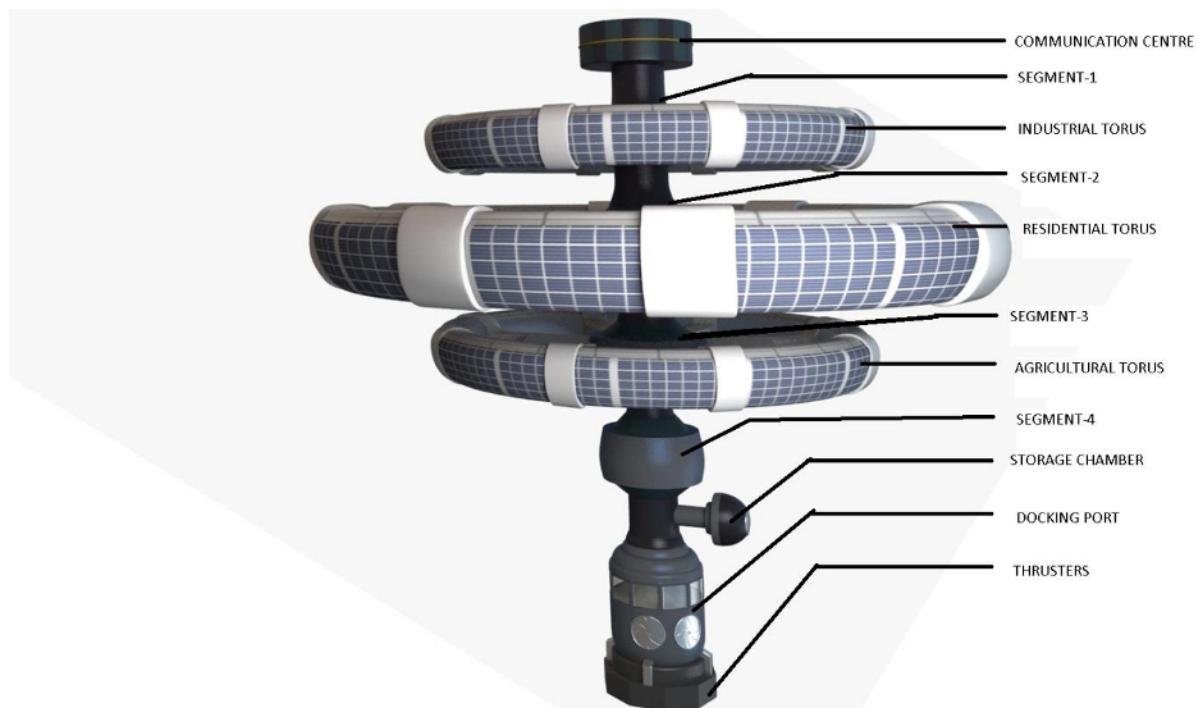


Figure 3 . The whole structure

# INGRESS

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*"A design is not how it looks or feels... its how it works"*

-Steve jobs.

Structural design is the first and for most that comes to our mind when we wish to built a space settlement. We have created a structure which is favorable to us in many ways. We poured the spice of hard work to design the structure of "INGRESS". Our settlement consists of a residential torus, an agriculture torus, an industrial torus, 4 segments, a docking station, along with a central rod. Our space settlement would provide housing for 12,760 members. Solar panels will be placed on the tori to obtain electricity through solar energy. The structure will be built with rigid materials to safe guard INGRESS.



Figure 4 . Top view of the settlement

# INGRESS

## 4.2 MAJOR COMPONENTS

### RESIDENTIAL TORUS:

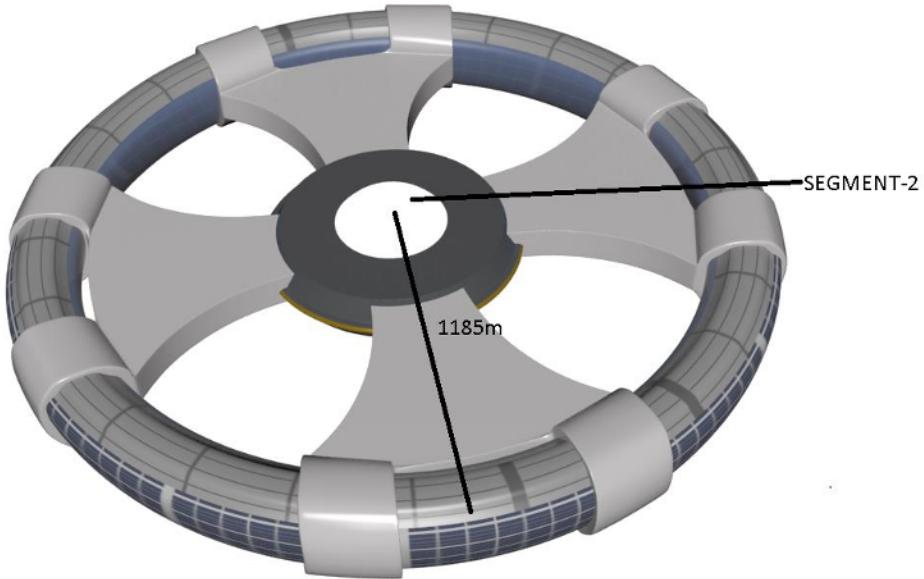


Figure 5 . Structure of the residential torus

Residential torus is one of the most dominant divisions of our settlement. So we have carefully depicted this part. We have selected hybrid torus for this unit because it is more efficient than the simple torus. Using simple torus creates gravitational fluctuation but Hybrid torus does not create any gravitational fluctuation. The spoke design - A has been used for the residential torus. 4 spokes of this design are connected to the torus. Each spoke is connected to the torus with the help of two clamps. The radius of this torus is 1185m, width of the land is 356, vertical height of the torus is 202m and the vertical height above the ground level is 169m. The RPM (Revolution per minute) of the torus can be calculated using the formula given below:

$$G = \frac{R \times \frac{\pi^2 \times rpm^2}{30^2}}{9.81}$$

R= radius

$\pi = \frac{22}{7}$

Rpm=revolution per minute

G=required gravity

This torus is found to have 0.87887 rpm.

# INGRESS

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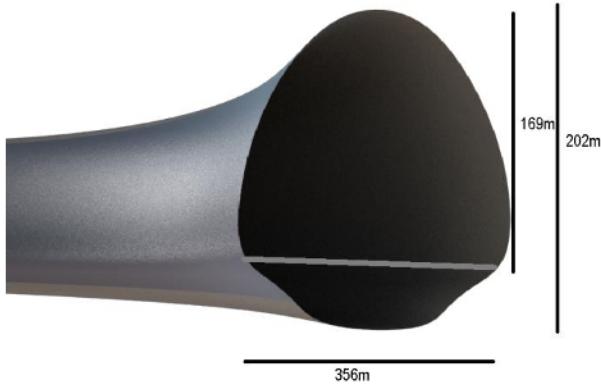


Figure 6 . Dimensions of residential hybrid torus

## AREAS & VOLUMES:

Volume of residential torus: We can take the shape of torus approximately as a triangle after flooring.

$$\begin{aligned} \text{So volume} &= \frac{1}{2} \times \text{triangle area} \times \text{circumference} \\ &= \left( \frac{1}{2} \times 169 \times 356 \times 2 \times \frac{22}{7} \times 1152 \right) \text{ m}^3 \\ &= 217,828,059 \text{ m}^3 \end{aligned}$$

The area of the land is = (breath of the land × circumference)

$$\begin{aligned} &= (1152 \times 2 \times \frac{22}{7} \times 356) \\ &= 2,577,846.85714 \text{ m}^2 = 2.577846857 \text{ km}^2 \end{aligned}$$

We can approximately consider the area and volume as 2,577,846.85714m<sup>2</sup>&217,828059m<sup>3</sup>.

## AGRICULTURAL TORUS:

This is the torus where the food production is done. We have selected truncated torus for this unit because it is very suitable for agriculture. Each spoke is connected to the torus by two clamps. Three spokes are connected to the torus. The spoke design- B has been used for this component. Radius of the torus 568m, width of the land is 189m, height with clamps is 198m, vertical height of the torus is 180m, vertical height of torus from the ground level is 169m, gravity of the torus is 0.7g and the rpm is 1.0794263. This torus is connected to the segment-3.

## INGRESS

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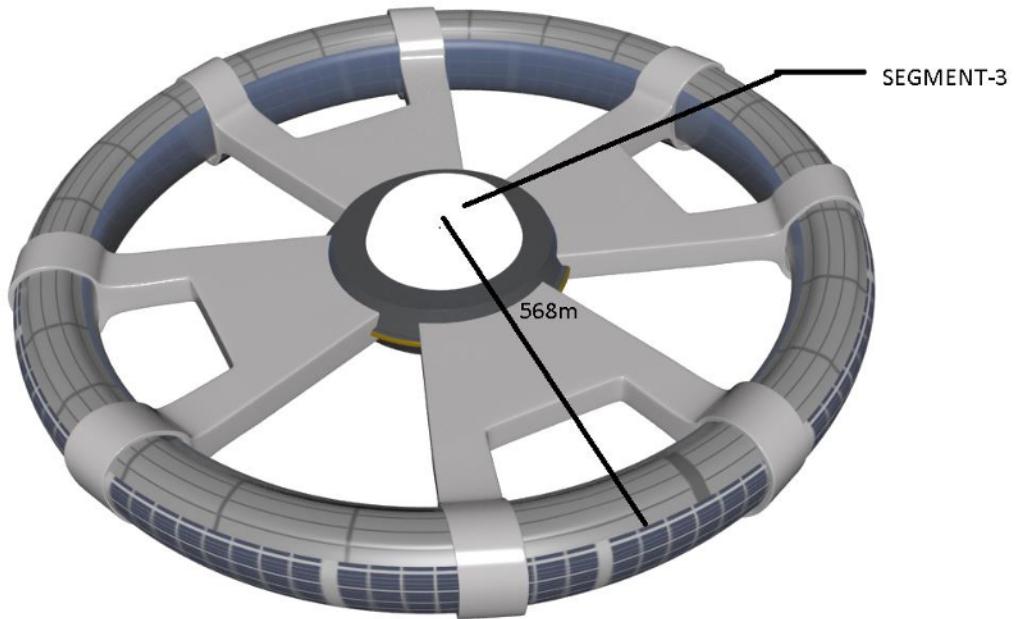


Figure 7 . Structure of the agricultural torus

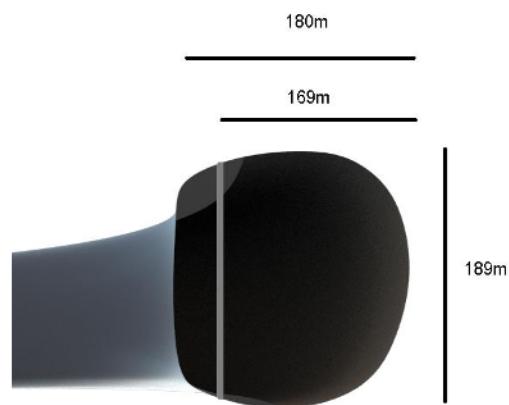


Figure 8 . Dimensions of the agricultural truncated torus

### AREAS & VOLUMES:

$$\text{Volume of the torus} = \frac{1}{2} \times \pi \times r^2 \times 2 \times \pi \times R$$

$$= \pi^2 r^2 R$$

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r = radius inside the torus

R = radius from central rod to torus

$$\text{Volume} = \left( \frac{22}{7} \times 104 \times 104 \times 537 \times \frac{22}{7} \right) \text{ m}^3$$

$$= 57,370,712.8 \text{ m}^3$$

Area of the land = (breath of the land × circumference)

$$= 189 \times 2 \times \pi \times R$$

$$= \left( 189 \times 2 \times \frac{22}{7} \times 537 \right) \text{ m}^2$$

$$= 637,956 \text{ m}^2$$

## INDUSTRIAL TORUS:

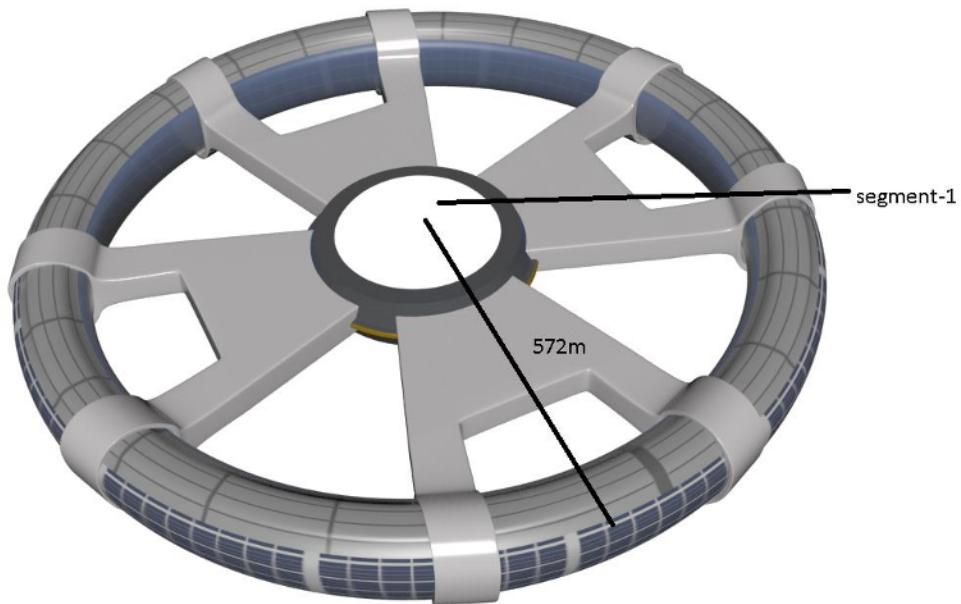


Figure 9 . Structure of the industrial torus

Industries are the future of our world. Therefore, a place would be provided for industries in our settlement. Industrial torus is one of the dominant components of the system. The whole development of "INGRESS" depends on industries. Industrial torus consists of many types of industries which collect raw materials like debris, cotton etc and transform them into new products. We have selected hybrid torus for this unit as well. Three spokes are connected to this component with the help of two clamps. The radius of this component is 572m, width of the land is 178m, height of the torus with clamps is 190m,

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vertical height of the torus is 174m and vertical height from the ground level is 142m. Gravity of this component is 0.7g and rpm is 1.07542372.

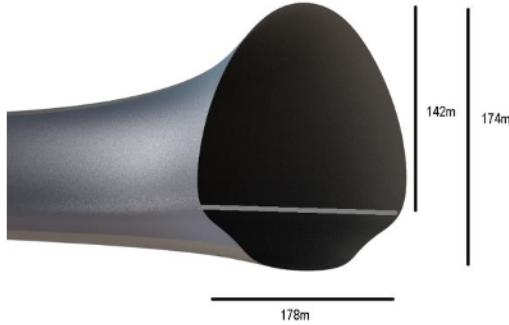


Figure 10 .Dimensions of the industrial hybrid torus

## AREAS & VOLUMES:

$$\begin{aligned} \text{Volume} &= \left(\frac{1}{2} \times \text{height} \times \text{base} \times \text{circumference}\right) \\ &= \left(\frac{1}{2} \times 142 \times 178 \times 2 \times \frac{22}{7} \times 540\right) \text{ m}^3 \\ &= 42896982.9 \text{ m}^3 \end{aligned}$$

The area of the land is = (breath of the land × circumference)  
=  $(178 \text{m} \times 2 \times \pi \times R) \text{ m}^2$   
=  $639986.2857142857 \text{ m}^2$

## CENTRAL ROD:



All the components are connected to the central rod. It is the main unit of the whole system. Rotational components are rotated with the help of this sector. This sector will not be rotated which means gravity is absent in the central rod. Transportation from one part to another is done inside this component. Height of central rod is 1278m and diameter is 213. With the help of the 3 rotational rings in central rod, artificial gravity will be generated in the tori. Storage chamber is also connected to this component. It plays the most dominant role in the whole system.

$$\begin{aligned} \text{Volume} &= \pi r^2 h \\ &= \left(\frac{22}{7} \times 11342.25 \times 1278\right) \text{ m}^3 \\ &= 45556957.28571429 \text{ m}^3 \end{aligned}$$

Figure 11 . The central rod

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SEGMENTS:

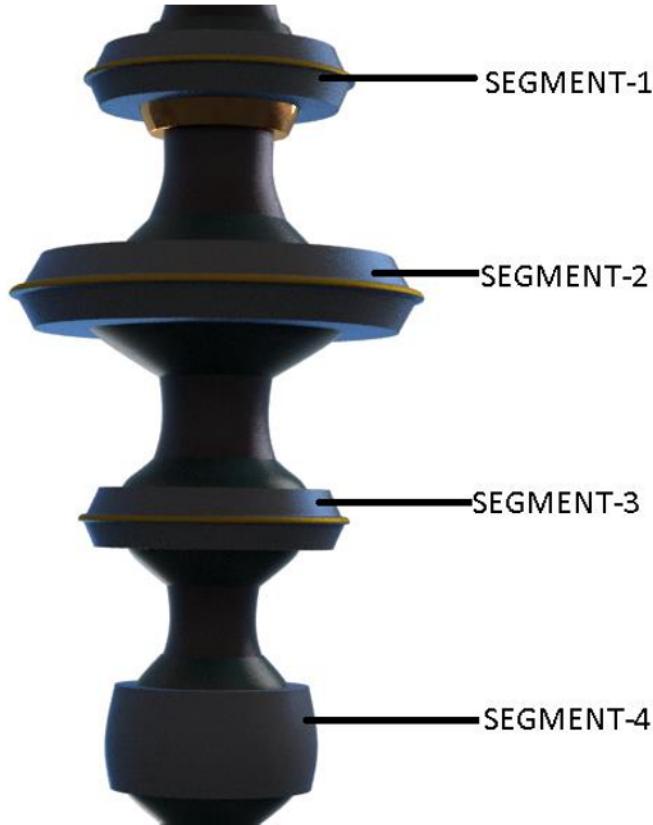


Figure 12 . Picture of segments along with the central rod

**SEGMENT-1:**

Segment-1 is a micro gravity component with a gravity level of 0.3288g. The segment-1 and industrial torus is connected with 3 spokes. Both of them will be rotated with same rpm of 0.75942372. This segment is totally used for research. Radius of this segment is 253.5m, ground width of this segment is 187m, Vertical height is 147m, and vertical height from ground level is 115m. These segments will be in the shape of cylinder.

**AREA and Volume:**

$$\text{Volume} = \pi r^2 h - \pi R^2 h$$

$$= \pi h (r^2 - R^2)$$

$$= \left(\frac{22}{7} \times 187 \times (253.5^2 - 106.5^2)\right) m^3$$

$$= \left(\frac{22}{7} \times 187 \times (64262.25 - 11342.25)\right) m^3$$

$$= \left(\frac{22}{7} \times 187 \times 52920\right) m^3$$

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= 31101840 m<sup>3</sup>.

R = radius of central rod

r = radius of segment

h = height of the segment

Area= h × circumference

$$= (187 \times 2 \times \frac{22}{7} \times 221.5) \text{ m}^2$$

$$= 260357.4285714286 \text{ m}^2.$$

h = height of segment.

## SEGMENT-2:

Segment-2 is used for government and control deck. It is connected to the residential torus and the rpm of this segment is same as the residential torus. Gravity of this segment is 0.43533g and the radius of this segment is 501m and ground width of this segment is 359m, vertical height is 394.5m, vertical height from ground level is 361.5m.

AREA and VOLUME:

$$\text{Volume} = \pi h (r^2 - R^2)$$

$$= (\frac{22}{7} \times 359(468^2 - 106.5^2)) \text{ m}^3$$

$$= \frac{22}{7} \times 359 \times (251001 - 11342.25) \text{ m}^3$$

$$= \frac{22}{7} \times 359 \times 239658.75 \text{ m}^3$$

$$= 270403544 \text{ m}^3$$

AREA= h × circumference

$$= (359 \times 2 \times 22/7 \times 468) \text{ m}^2$$

$$= 1056075.428571429 \text{ m}^2$$

## SEGMENT-3:

Segment-3 is the microgravity complex. It is connected to the agricultural torus. Gravity of this component is 0.36139g and rpm is same as agricultural torus, radius of this segment is 253.5, ground width of this segment is 187m, vertical height is 147m, vertical height from ground level is 115 m. So we can say that dimensions of segment-1, segment-3 are equal and seeing by this we can also tell that volume and area is same as that of segment-1.

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## SEGMENT-4:

In our settlement we need a zero gravity. So, we are using this segment-4 as zero gravity complexes. Ground width of this segment is 163m and radius is 243.5, vertical height is 137m, vertical height from ground level is 105m. This segment is not connected to any torus.

## AREA & VOLUME:

$$\text{VOLUME} = \left(\frac{22}{7} \times 163(243.5^2 - 106.5^2)\right) \text{ m}^3$$

$$= \left(\frac{22}{7} \times 163(44732.25 - 11342.25)\right) \text{ m}^3$$

$$= \left(\frac{22}{7} \times 163 \times 47950\right) \text{ m}^3$$

$$= 24564100 \text{ m}^3$$

$$\text{AREA} = L \times B$$

$$= (163 \times 2 \times 22/7 \times 243.5) \text{ m}^2$$

$$= 249,483.143 \text{ m}^2.$$

## DOCKING PORT:



Figure 13 . Structure of the docking port

The docking port is the sector which allows us to go out and come in to the system. The whole station has 6 inlets and 6 outlets, 8 ports will be used for small and medium space craft's inlet and outlet and the other 4 ports will be used for large sized space craft's inlet and outlet. Importing and exporting goods will be done with the help of this docking station. This is connected to extreme end of the central rod and thrusters are connected to this component.

## DOCKING PLACE:

We will have two docking places of different dimensions in the Docking port. The Docking port consists of 8 small ports and 4 big ports. The small docking port has a height of 198m, runway of 232m and width of 102m. Large docking port will be in the shape of circle. So, the radius of circle is 144m. After entering into the settlement through the docking port, the vehicles would be parked in the maintenance chamber. Vehicles will be sent to a service center where machines will check the percentage of damage occurred to the vehicles. If a spacecraft is damaged more than 6% it will be sent to repair house where the vehicle will be repaired up to 100%. If a vehicle is damaged more than 84%, it will be recycled. The vehicles which are damaged less than 6% will be sent to parking station.

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## 4.3 MINOR COMPONENTS

### SPOKES:

For connecting a segment to a torus and for transportation from the central rod to torus we need spokes. We made two spoke designs and namely, they are marked as spoke design A&B.

#### SPOKE DESIGN - A

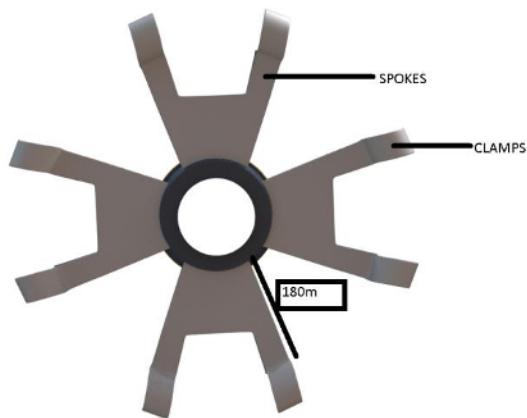


Figure 14 . Structure of spoke design-A

Spoke design-A is used for connecting segment-2 and the residential torus. The length of each spoke is 482.5m. It is connected to torus by 2 clamps and connected to segment by an attachment. It is specially designed for residential torus. It has higher dense than all the other spokes. These spokes would also be used to transport people or goods from the residential torus to other places.

#### SPOKE DESIGN - B

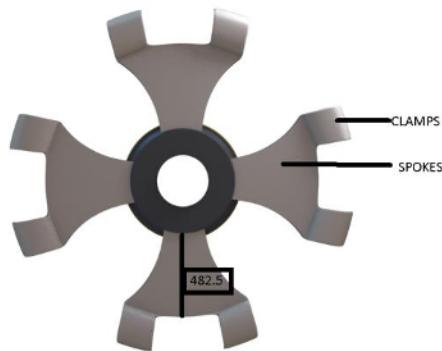


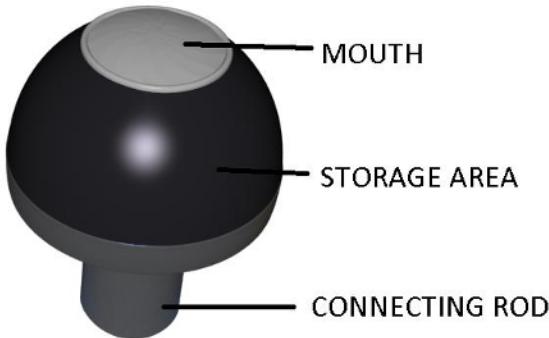
Figure 15 . Structure of spoke design -B

Spoke design-B is used for the agricultural torus and industrial torus. Spokes are connected to the torus with the help of clamps. The spokes are divided into two parts at the ending of each spoke. The spokes

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used for the agricultural and industrial spokes are different in lengths. Length of the agricultural spoke is 180m industrial spoke is 145m. The agricultural spoke connects the agricultural torus and segment III and the industrial spoke connects industrial torus and segment I. This spoke design has 3 spokes; each spoke will be in "Y" shape. The breadth of the spoke is more near the torus and less near the segment.

## STORAGE CHAMBER:



We have designed an exterior storage chamber because it would be very comfortable to have an additional storage space. It will be in the shape of a hemisphere with a radius of 15m. It is connected to the central rod with the help of a cylinder shaped connector. It would be protected by an additional shield. This storage chamber would be used to store emergency machinery and other material.

Figure 16 . External storage chamber

$$\text{Volume} = \frac{2}{3}\pi r^3$$

$$= \left( \frac{2}{3} \times \frac{22}{7} \times 15^3 \right) \text{m}^3$$

$$= 7071.42855 \text{ m}^3$$

This component is installed with a mouth at top for an easy transport of machineries

## ROATATIONAL RINGS:

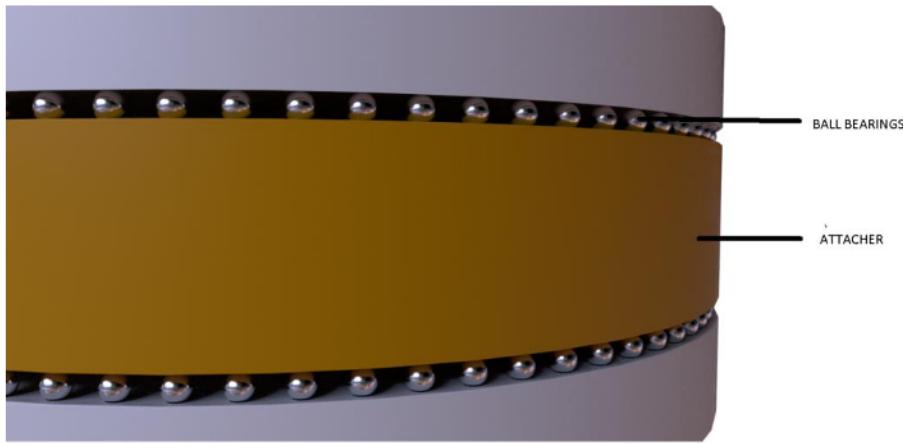


Figure 17 . Picture of the rotational rings

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The rotational rings are used to rotate the tori and segments to create artificial gravity. Rotational rings are connected to the segments. By using these, the segments and the tori will rotate .Totally there will be three rotational rings for the three tori. This is a very important component as it will be used to create gravity. Ball bearings would be used for smooth rotations. The speed of the rotational rings will be controlled by the control deck in segment II. These rings will be attached on the central rod; daily checkups will be attained to ensure the safety of the rings.

## 4.4 DIMENSIONS.

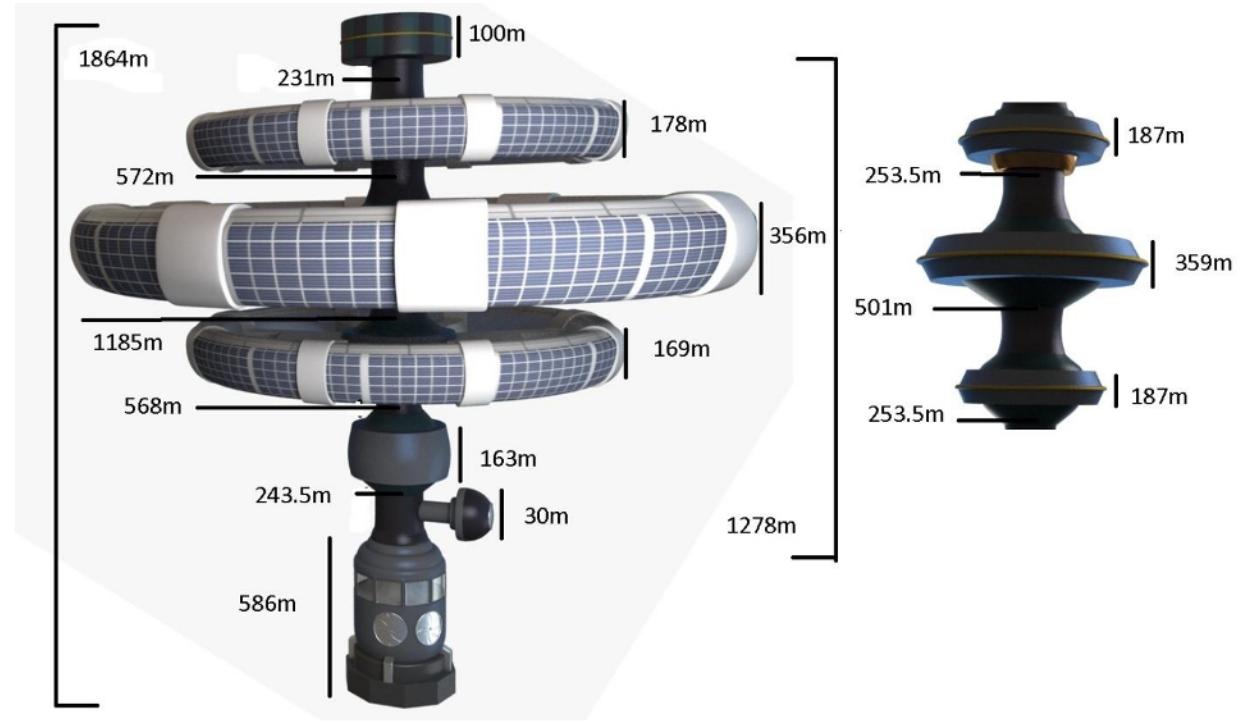


Figure 18 . Exterior dimensions of the structure

Component	Radius	Vertical clearance	Ground width	Height of torus with clamps	Area	Volume
Residential torus	1185m	202m	356m	375m	2577846.857m <sup>2</sup>	217828059m <sup>3</sup>
Industrial torus	572m	174m	178m	190m	604182.857m <sup>2</sup>	42896982m <sup>3</sup>
Agricultural torus	568m	135m	189m	198m	637956m <sup>2</sup>	573703712.8m <sup>3</sup>
Segment I	253.5m	147m	187m	-----	2979713.143m <sup>2</sup>	31101840m <sup>3</sup>
Segment II	501m	394.5m	359m	-----	1130542.29m <sup>2</sup>	270403544m <sup>3</sup>
Segment III	253.5m	147m	187m	-----	297971.143m <sup>2</sup>	31101840m <sup>3</sup>
Segment IV	243.5m	137m	163m	-----	249483.143m <sup>2</sup>	24564100m <sup>3</sup>
Central rod	106.5m	1278m	-----	----	-----	45556957.2857m <sup>3</sup>

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## 4.5 INTERIOR STRUCTURE:

### RESIDENTIAL TORUS INTERIOR STRUCTURE:

The residential torus is divided into 4 colonies with the help of 4 standard zones. Each zone has a length of 81 m and each colony has a length of 1729.28572m. Area of each standard zone is 28836.0012m<sup>2</sup>. Area of each colony is 615625.714m<sup>2</sup>. The area provided for each person in the colony is approximately 193m<sup>2</sup>, area provided for each person in common side is approximately 10 m<sup>2</sup>. The total area allotted for each person in residential torus is 203 m<sup>2</sup>. The interior structures of all colonies are similar and the interior structures of all the standard zones are similar.

### COLONIES:

The residential torus would have 4 residential colonies. The residents would live in these colonies, INGRESS would provide the best residential facilities for the residents and most of them will be in the residential colonies. The following table shows the details about the colonies.

Criteria	Area/person	Ground provision	Percentage
Banks	1.92986118m <sup>2</sup>	6156.25714m <sup>2</sup>	1
Community halls	3.85972236m <sup>2</sup>	12312.5143m <sup>2</sup>	2
Fire station	0.96493059m <sup>2</sup>	3078.12858m <sup>2</sup>	0.5
Holy places	5.78958354m <sup>2</sup>	18468.7715m <sup>2</sup>	3
Gymnasiums	9.6493059m <sup>2</sup>	30781.2858m <sup>2</sup>	5
Hospitals	11.5791671m <sup>2</sup>	36937.543m <sup>2</sup>	6
Life Support	11.5791671m <sup>2</sup>	36937.543m <sup>2</sup>	6
Markets	15.4388894m <sup>2</sup>	49250.0574m <sup>2</sup>	8
Municipal parks and ponds	11.5791671m	36937.543m <sup>2</sup>	6
Recreation	9.6493059m <sup>2</sup>	30781.2858m <sup>2</sup>	5
Residential colony	65.6152828m <sup>2</sup>	209312.752m <sup>2</sup>	3
Trees and bushes	5.78958354m <sup>2</sup>	18468.7715m <sup>2</sup>	3
Transportation, foot paths	10.6142365m <sup>2</sup>	33859.4143m <sup>2</sup>	5.5
Free spaces for future expansion	28.9479177m <sup>2</sup>	92343.8572m <sup>2</sup>	15
Total	192.986118m <sup>2</sup>	615625.714m <sup>2</sup>	100

# INGRESS

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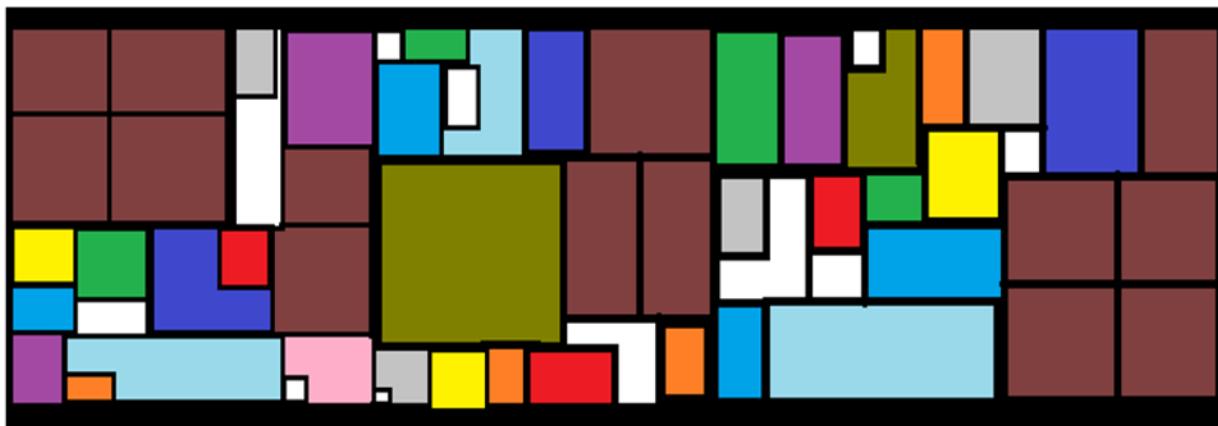


Figure 19 . Interior structure of a colony

[Brown]	Residential colony	[Dark Teal]	Markets
	Free space for future expansions	[Light Blue]	Gymnasiums
[Yellow]	Community hall	[Light Green]	Life support
[Green]	Banks	[Teal]	Hospitals
[Dark Teal]	Recreation	[Light Green]	Trees and bushes
[Black]	Transportation roads and foot paths	[Olive Green]	Holy places
[Red]	Fire station	[Dark Green]	Parks and ponds

## STANDARD ZONE:

4 standard zones will be constructed inside the residential torus. These zones will have common facilities such as schools. They will be built between the 4 colonies. We have introduced this concept because it would be easy for people to access the common facilities very easily. These zones will also have storage components and electricity generators in them.

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Criteria	Area per person	Ground provision	Percentage
Entertainment (cinema theatres, parlors etc.,)	0.63276499	2018.5201	7
Graveyard	0.09039499	288.36002	1
Shopping complex	0.18078998	576.72004	2
Hospitals	0.72315992	2306.8802	8
Offices	1.17513487	3748.6803	13
Pre schools	0.36157996	1153.4401	4
Schools	0.45197495	1441.8001	5
High schools	0.49717244	1585.9801	5.5
Universities	0.54236994	1730.1601	6
Storage	1.3559248	4325.4003	15
Electrical chamber	0.81355491	2595.2402	9
Water storage	0.72315992	2306.8802	8
Free space for future expansion	1.49151173	4757.94	16.5
Total	9.03949882	28836.001	100

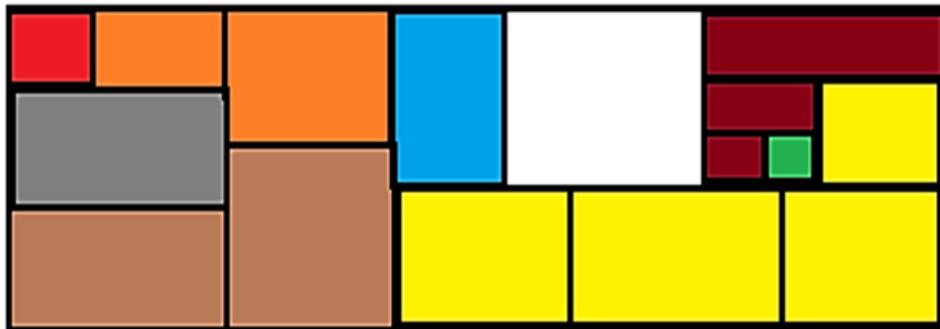


Figure 20 . Interior structure of standard zone

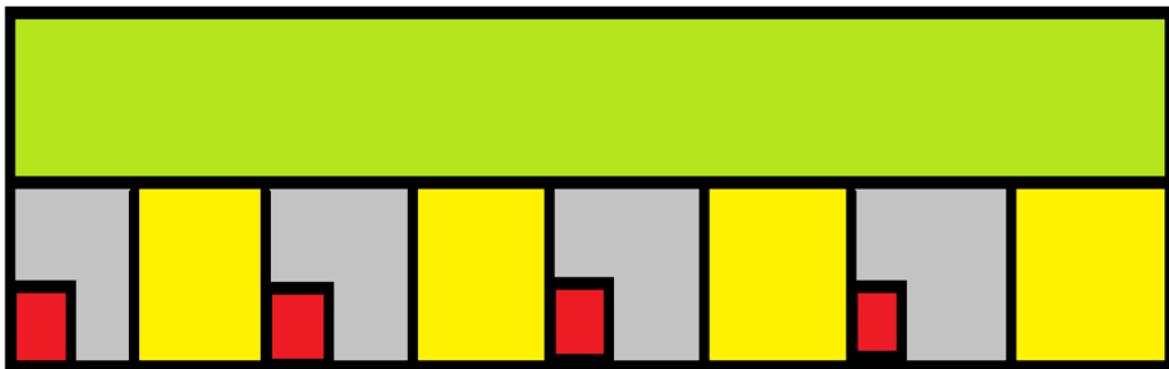
	Hospitals		Schools
	Storage		Offices
	Free space for future expansions		Graveyards
	Water storage		Shopping complex
	Electrical chamber		Transportation

# INGRESS

## AGRICULTURE TORUS:

The agricultural torus of ingress is divided into 4 sectors; they are the agriculture sector, animal husbandry, storage and control deck. According to this, we have designed interior structure.

Criteria	Percent	Ground provision
Agriculture	50%	318,978m <sup>2</sup>
Animal husbandry	25%	159,489m <sup>2</sup>
Storage	20%	127591.2 m <sup>2</sup>
Control desk	4%	25,518.24 m <sup>2</sup>
Transportation	1%	6379.56 m <sup>2</sup>
total	100%	637,956 m <sup>2</sup>



	Control deck		Agriculture
	Animal husbandry		Storage

## 4.6 CONSTRUCTION

### CONSTRUCTION SEQUENCE:

#### PHASE-1:

Phase-1 would be constructed in the lunar base and sent to the LEO. The required materials would be sent to the moon using the falcon rocket. The lunar base would be constructed first. After the construction of lunar base, the central rod, the segments and the storage chamber would be constructed. The further construction materials will be stored in the storage chamber which is a component of the lunar base.

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## PHASE 2:

In this phase, the construction of docking port, communication centre and spokes will take place. These components will be connected to the central rod during this phase.

## PHASE 3:

This phase includes the construction of agriculture torus and the industrial torus. Photovoltaic solar panels will also be placed on these tori during phase-3.

## PHASE 4:

During phase 4, the construction of residential torus along with some other minor components will be completed. This would be the final phase of construction of the settlement. After this phase, the initial construction of ingress will be completed.

## CONSTRUCTION MATERIALS:

### CONSTRUCTION MATERIALS OF WINDOWS:

Windows are very essential to our structure to prevent from diseases like claustrophobia etc. These Diseases may lead to death. Normal windows are not very comfortable in space. We would use different types of transparent layers for these windows, the first layer is tempered glass which gives strength to the windows, the second layer is transparent aluminum which protects the residents from beta rays, the third layer is lead glass which can be used to protect the residents from alpha rays, gamma rays and x-rays, fourth layer is of diamond aero gel which protects the people from harmful cosmic rays, fifth layer is also tempered glass which will be used for strength. Illumination windows would be covered by transparent solar panels which could be used to protect the people of ingress from UV rays (Ultra Violet radiations).

### TILING OF THE TORUS:

In tiling of the tori we would use titanium alloy as the first layer due to its high tensile strength, high melting point, it is also light weight and it has extraordinary corrosion resistance. The second layer is of lead bricks which will be used to defend the residents from harmful radiations like alpha rays, gamma rays and x-rays. The third layer is aluminum, this protects from cosmic rays which disturbs the humans D.N.A and protects them from beta rays. The fourth layer is of diamond aero gel which is very strong and provides shielding from cosmic rays. The fifth layer is for spider silk fiber which makes the tiling strong. The last and sixth layer is silicon carbide which can be used for strength. Totally, there are six layers of protection for the settlement.

### Thickness of the layers:

Titanium alloy	- 1m
Lead brick	- 0.8m
Aluminum	- 0.9m
Diamond aero gel	- 0.6m
Spider silk fiber	- 0.2m
Silicon carbide	- 0.4m

### TILING PROCESS:

Initially, a titanium frame would be constructed. This layer will be increased in the frame later. Caulobacter crescentusill glue will be used between two layers to stick them together.



Figure 21 . Caulobacter crescentusill bacterium

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Caulobacter crescentusill is a tiny water bacterium with an adhesive force of nearly five tons per square inch. This is also known as the world's stickiest glue. After sticking the two layers, a sheet of management alloy will be covered around these layers to ensure safety. By using this method, the system becomes strong.

## FLOORING:

Flooring of these components consists of 5 layers. The first layer is of 80% nafion, 17% polystyrene dimethyl siloxane di-block co-polymer, 2% amorphous silica this layer is mainly used for constructing a strong foundation for buildings. Tungsten is used as the second layer due to its hardness. Third layer is for electric wiring. Rubber would be used in the fourth layer due to the water related works below this layer. Fifth layer is of water pipes and the last layer is of sewage pipes.

## 4.7 LUNAR BASE

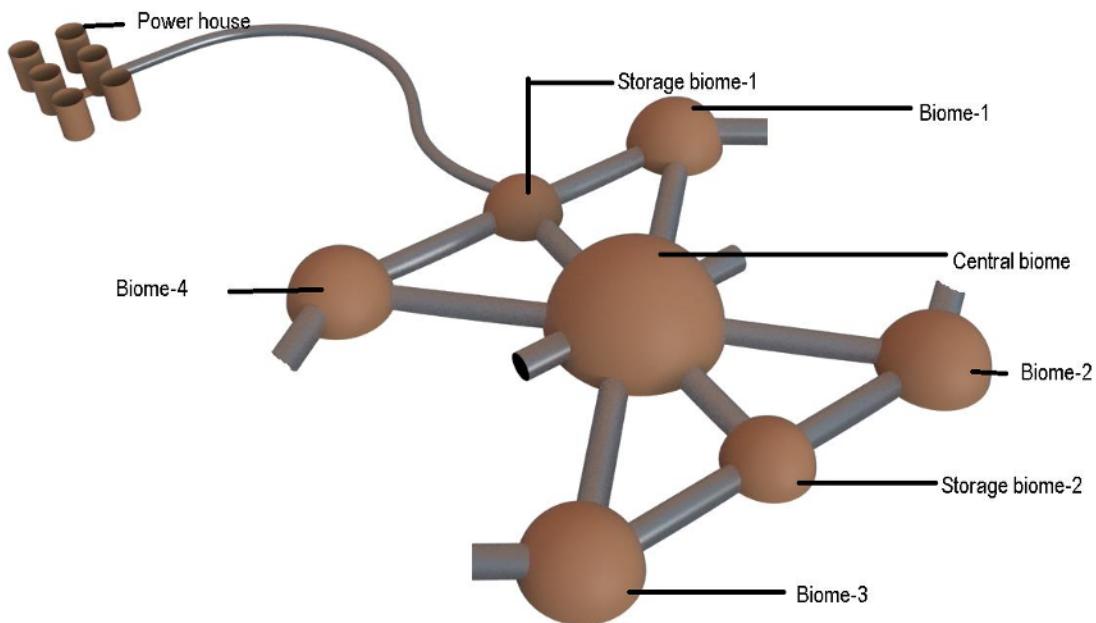


Figure 22 . The Lunar base

## CENTRAL BIOME:

Central biome is the place where all the residential facilities are located. It connected to all the other components. It acts as the main part of the lunar base.

## BIOME 1:

The control deck will be located in here. The whole lunar base along with some other minor components of the settlement will be controlled by this biome.

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## BIOME 2:

This biome will be used for agriculture. Food which is not available in the settlement will also be manufactured here.

## BIOME 3:

This biome would be used for the mining and extraction industries. These industries would be used to mine and extract all the minerals which will be available on the moon.

## BIOME 4:

This biome would be used for storage. This component will be used to store materials which would be used to build the settlement and to store the extracted minerals.

## STORAGE BIOME 1:

This biome will be used for storing the agricultural products, Industrial products, and mining machines.

## STORAGE BIOME 2:

This biome is used for storing the minerals extracted from moon.

The lunar base contains a power storage and generation center as well. The power would be sent directly to the central biome and electricity will be sent to all biomes from there. Photovoltaic solar panels would be used for electricity generation in lunar base. The lunar base also contains docking port for parking spacecraft's.

## LOCATION OF THE LUNAR BASE:

The lunar base will be built at the northern rim of Peary (crater).

## REASONS FOR CHOOSING THIS LOCATION:

- It is illuminated whole lunar day; we can get much solar power due to this.
- It has a stable temperature. During sunrise the temperature is 25°C, so we can say that the temperature at this location is better compared to the other locations.
- It is also very near to permanently shadowed areas. Here we can get some quantity of frozen water.
- Many minerals are located here.

## MINING:



The moon holds many valuable minerals such as ilmenite, iron, gold, titanium etc. With the help of ilmenite, we can also get many valuable materials such as oxygen, titanium and water. Even the lunar soil can be used in many ways.

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## 5. LIFE SUPPORT.

### 5.1 ARTIFICIAL GRAVITY

As INGRESS has a population of 12,760 citizens, gravity is mandatory. INGRESS would have a gravity generating system for each major component. INGRESS would generate earth like gravity for the welfare of citizens. If gravity lacking, it would be strenuous to maintain the settlement.

#### GENERATING ARTIFICIAL GRAVITY:

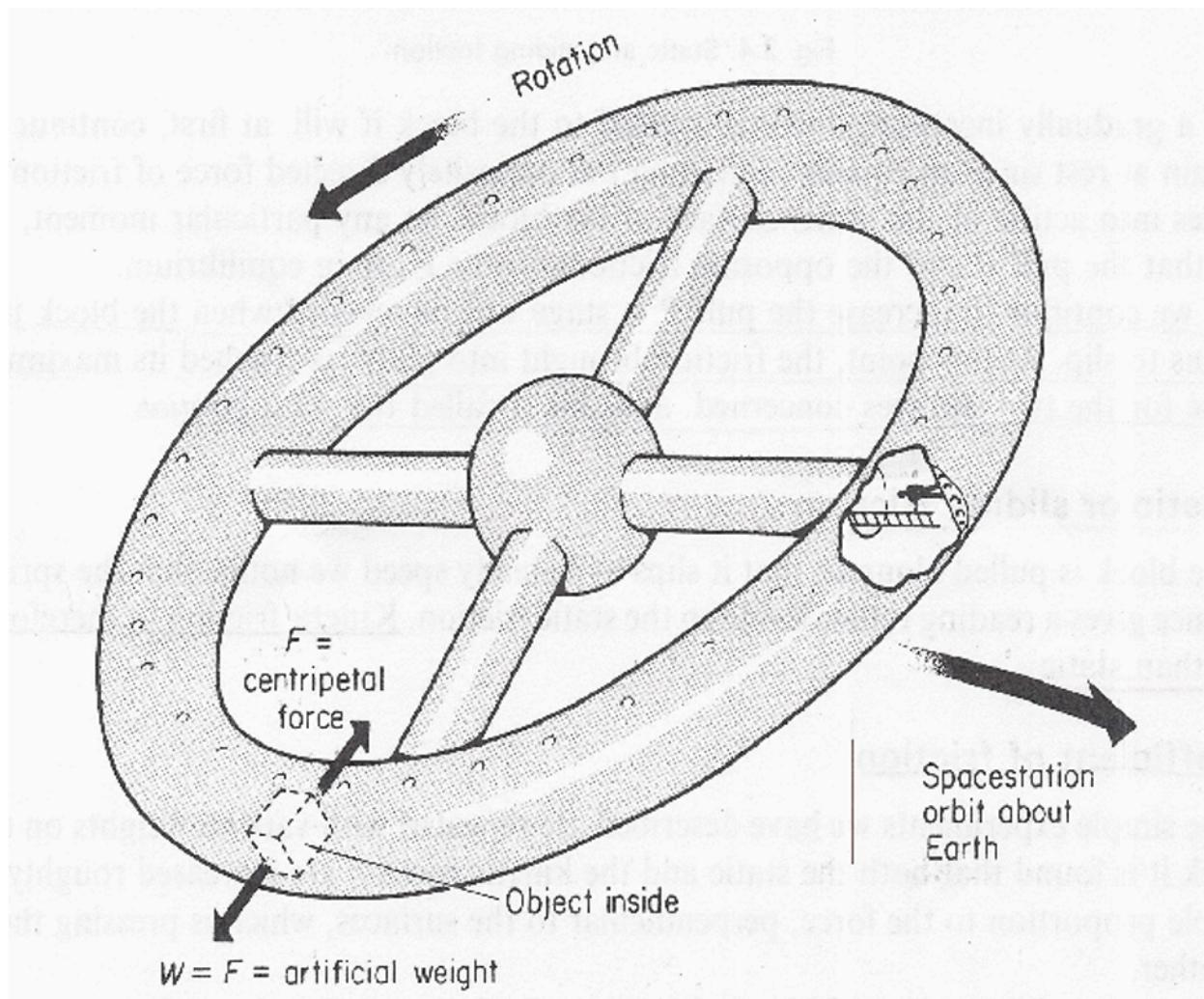


Figure 23 . Artificial gravity generation

The reason that gravity is not present in space is because the normal force is absent. To generate a normal force which resembles earth, a space craft would have to travel with an acceleration of  $9.8\text{m/s}^2$ . However, this would consume a huge unrealistic amount of fuel, which is the reason that this method is not really feasible. However, there is a better way to create artificial gravity in space. This method works on centripetal force. If we create a station in the form of a ring and rotate it, it would simulate gravitational force acting towards the outside of the station. This would have a gravity resembling the

# INGRESS

earth's gravity for the residents inside the space city. INGRESS uses this concept to generate gravity inside settlement.

Part name	Amount of gravity and RPM	Purpose of gravity level
Residential hybrid torus	1g	This is the place where the residents live. Residential hybrid torus will have the same gravity level as the earth to make the residents feel comfortable.
	RPM 0.808	
Agricultural truncated torus.	0.7 g	Low gravity helps in faster growth of plants. The upward movement of water and minerals from root to parts of plant happens against gravity. If gravity is low the movement of water would be free which leads to faster growth in plants.
	Rpm 1.079	
Industrial hybrid torus.	0.7 g	Industrial torus will have a gravity of 0.7g for easier movement of heavy objects or materials and it would reduce the work load of the machinery.
	Rpm 1.0754	
Segment-1	0.328g	As the segments are attached to the tori, the gravity levels of the 3 segments depend on the gravity level of the tori.
	Rpm Same as torus	
Segment-2	0.435g	Segment-3 is the microgravity complex and the low gravity in it would be perfect for it.
	Rpm Same as torus	
Segment-3	0.361g	
	Rpm Same as torus	
Segment-4	No rotation ( 0g )	Segment-4 is the zero-gravity complex. Hence, it does not rotate.

## 5.2 ATMOSPHERE

Every living organism needs a comfortable and life supportable atmosphere. INGRESS is not going to fill the atmosphere with harmful gasses which would give a hazardous environment to the residents. INGRESS would generate artificial atmosphere in order to make the residents feel comfortable. Without creating an artificial atmosphere, life would not be possible in the settlement.

Gases	Percentage
Nitrogen	62.05%
Oxygen	18.95%
CO <sub>2</sub>	17.77%
Others	2.23%

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## RESIDENTIAL HYBRID TORUS:

INGRESS would create an atmosphere which resembles the earth. The residential torus has all the gases balanced. In this torus we require less amount carbon dioxide ( $\text{CO}_2$ ) and huge amounts of oxygen ( $\text{O}_2$ ) and nitrogen. A normal man consumes over 0.84 kg of  $\text{O}_2$  per day. So, we need a minimum 20% of oxygen in the residential torus. Nitrogen is essential to produce ammonia used in the construction of nucleotides and amino acids. The following table shows the atmosphere of the residential torus

Gases	percentage
Nitrogen	73.07%
Oxygen	20.93%
$\text{CO}_2$	5.2%
Others	0.8

## AGRICULTURAL TORUS:

Agricultural torus is divided into 4 parts. Atmosphere in these four parts is decided according to the conditions.

## ANIMAL HUSBANDRY:

Atmosphere in Animal husbandry is will be different in two parts. One of them is for poultry while the other part would be for cattle.

### ATMOSPHERE IN POULTRY:

GASES	PERCENT
NITROGEN	72.08%
OXYGEN	10.62%
$\text{CO}_2$	16.30%
OTHER	1.00%

### ATMOSPHERE IN CATTLE:

Gases	Percent
Nitrogen	70.87%
Oxygen	18.13 %
$\text{CO}_2$	10.70%
Others	0.3%

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## STORAGE:

SILO: Silo is a tall tower or pit on a farm used to store grain. Silo is used to store harvested crops. So, we need an atmosphere which will enable us to keep the crops fresh.

BARN: barns are places where we will be storing the products which are produced in animal husbandry.

Atmosphere in the storage chamber:

Gases	Percent
N <sub>2</sub>	78.08%
O <sub>2</sub>	18.92%
CO <sub>2</sub>	2.72%

## CONTROL DECK:

The control deck would have the control of all the machines in agricultural torus. The control deck also needs some oxygen because machines in control deck are manually controlled by humans.

Atmosphere in the control deck:

GASES	PERCENTAGE
Nitrogen	69.39%
Oxygen	20.51%
CO <sub>2</sub>	9.1%
Others	1.0%

## INDUSTRIAL TORUS:

Industrial torus is the place where all the raw materials are transformed into products by machineries. This torus is quite different from other two torus i.e. agricultural torus & hybrid residential torus. Oxygen will be low in this sector the industries will mainly be operated by humans from the control room. Some of the machines will be operated by humans.

Atmosphere in industrial torus:

GASES	PERCENTAGE
Nitrogen	79.70%
CO <sub>2</sub>	12.30%
O <sub>2</sub>	7.00%
Others	0.50%

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## CONTROL ROOM:

In Industrial area, most of the work is done by robots. So, in order to control the machines, humans will control them from the control room.

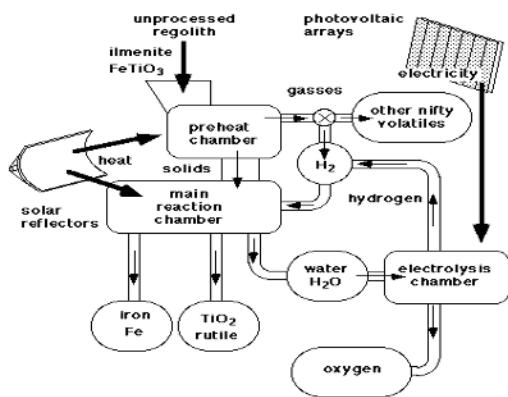
## ATMOSPHERE IN THE CONTROL ROOM OF INDUSTRIES:

Gases	Percentage
Nitrogen	75.39%
O <sub>2</sub>	19.11%
CO <sub>2</sub>	4.0%
Others	0.4%

## EXTRACTION OF OXYGEN:

Oxygen is the gas that supports most of the organisms to live. A normal human consumes about 0.84 kg/day. So, INGRESS has the population of 12,760 which means it needs about 10,000 kg/day. However 40% of oxygen is generated from agricultural torus and other 60% of oxygen is produced from either methods of extraction

## OXYGEN FROM LUNAR SOIL:



Lunar soil contains about 42% of O<sub>2</sub> in it. So, we are going to extract O<sub>2</sub> by mining ilmenite. By using the hydrogen reduction process, we are going to extract oxygen.

Hydrogen reduction process:

After the hydrogen reduction the reaction of ilmenite is:

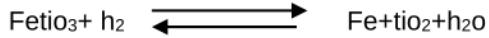


Figure 24 . Extraction of oxygen from ilmenite

Electrolysis method:

By using electrolysis method, we can extract oxygen. The electrolysis reaction is given below:



## OXYGEN EXTRACTION PILOT PLANT:

By using this machine we can extract oxygen from ilmenite.

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**EXTRACTION OF NITROGEN:** Nitrogen is also an essential gas required for creating atmosphere in INGRESS. Ammonia would be separated from meteorite dust which would later be decomposed thermally to produce nitrogen and hydrogen and they can be further separated using techniques such as fractional distillation. Nitrogen will also be extracted from asteroids captured by INGRESS such as 3671 Dionysus which is rich in ammonia and nitrogen.

## CLIMATIC CHANGES

### 1. ARTIFICIAL SEASONS:

INGRESS will have three main seasons. They are summer, winter and rainy seasons. The seasons in space cannot be created automatically as in earth. So, for creating artificial seasons we will be using a machine called ICC (INGRESS CLIMATE CHANGER). This machine has a container that is attached with electric heaters and electric coolers. In this container, water will be used for creating climate. This machine works by cooling the water in the container with the help of electricity. After cooling the water, the cool air produced will be released inside the component. By using this method, we can create winter season. For summer season, we would increase the temperature of the water. By increasing the temperature, hot vapor will be produced and this vapor will be transferred into system. Summer season would be created using this method. For creating rainy season we will be mixing hot and cool vapors, this will create rainy atmosphere but it doesn't rain. The temperature and humidity during each season are listed below.

Season	Temperature	Humidity
Summer	25°c -35°c	30%-35%
Winter	10°c-20°c	28%-30%
Rainy	15°c-25°c	50%-70%

## 5.3 AGRICULTURE

Food is one of the basic needs of human life. Without food we cannot even live a single day. To get food we must perform activities such as cultivate crops, grow animals which gives us food. We need some space to perform agricultural activities, that is the reason our settlement has a special truncated torus which is suitable for agriculture. We will learn more about agriculture in ingress as we go through the topic.

### LAND PROVISION IN AGRICULTURAL TORUS

Agricultural torus is divided into 4 parts in our settlement. These parts are for agriculture, animal husbandry, storage, control desk. In the agricultural torus, 50% land is provided for cultivating crops, 35% of area is for animal husbandry, 10% of area is for storage and 5% of area is for control deck.

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Parts	Percentage	area
Agriculture	50%	318978 m <sup>2</sup>
Animal husbandry	35%	223284.6 m <sup>2</sup>
Storage	10%	63795.6 m <sup>2</sup>
Control desk	5%	31897.8 m <sup>2</sup>

## AGRICULTURAL METHODS:

Agriculture on earth and agriculture on INGRESS is quite different because; we cannot cultivate plants with the help of soil in the space because we would lack in soil, so we have introduced different methods to cultivate in space. They are hydroponics, Zeoponics, Aeroponics and Aquaponics.

### HYDROPONICS:

This is a method of agriculture that is done with the help of mixing nutrients in water. The water which is mixed with nutrients will be transported to every plant root by the process of drip irrigation. The nutrients that are mixed with water are micro and macronutrients like potassium, phosphorous, nitrogen etc. So, for the fertility and free growth of plants we are going to inject CO<sub>2</sub> into their atmosphere.

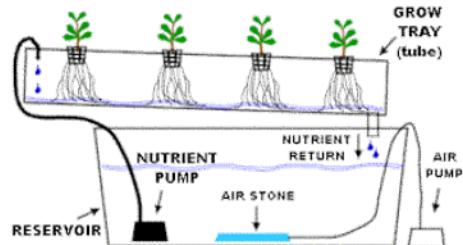


Figure 25 . hydroponics

### AEROPONICS:

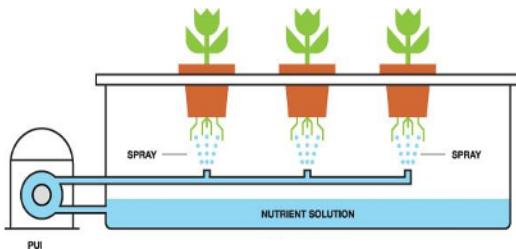
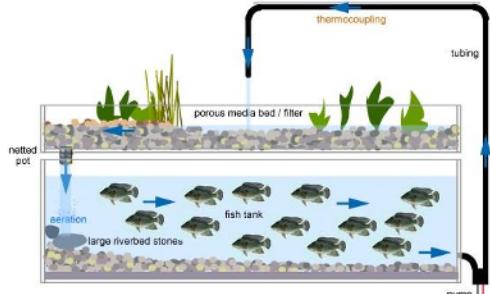


Figure 26 . Aeroponics

Aeroponics is a method for growing crops with the help of air and mist. In Greek 'aero' means air and 'phonics' means labor. Aeroponics is also known as geponics. Nutrients are given to plants with the help of sprayers or by giving nutrients to roots.

### AQUAPONICS:



Aquaponics is also a method of agriculture and this includes fishes in it. The manure that is released by the fish is used as the nutrients for the growth of crops. Some nutrients are also added to it by observing the breathing and the nutrients needed for fish.

Figure 27 . AQUAPONICS

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## ZEOPONICS:



Zeponics is the process that is only done with the help of making artificial soil containing useful nutrients and a main nutrient called as zeolite. This also contains different layers in the soil like soil concrete, rocks etc.

**Figure 28 . Zeponics**

## TYPES OF CROPS GROWN IN INGRESS:

### Vegetables and cereals

Crops grown	Suitable methods	Percentage of growth	Area required
Tomatoes	Hydroponics	3%	9569.34 m <sup>2</sup>
Radishes	Hydroponics	2%	6379.56 m <sup>2</sup>
Celery	Hydroponics	5%	15948.9 m <sup>2</sup>
Cucumbers	Hydroponics	6%	19138.68 m <sup>2</sup>
Wheat[cereals]	Aeroponics	20%	63795m <sup>2</sup>
Potatoes	Aeroponics	4%	12759.12 m <sup>2</sup>
Peas	Aeroponics	3%	9569.34 m <sup>2</sup>
Onions	Aeroponics	5%	15948.9 m <sup>2</sup>
Kale	Aeroponics	1%	3189.78 m <sup>2</sup>

### Leafy vegetables

Crops grown	Suitable methods	Growth percentage	Area
Lettuce	Hydroponics, aeroponics	2%	6379.56 m <sup>2</sup>
Spinach	Hydroponics	7%	22328.46 m <sup>2</sup>
Basil	Hydroponics	2%	6379.56 m <sup>2</sup>
Coriander	Hydroponics	3%	9569.34 m <sup>2</sup>
Arugula	Aeroponics, aquaponics	6%	19138.68 m <sup>2</sup>
Cauliflower	Aeroponics	4%	12759.12 m <sup>2</sup>
Celery	Aeroponics	5%	15948.9 m <sup>2</sup>
Squash	Aeroponics, aquaponics	4%	12759.12 m <sup>2</sup>
Amaranth	Aeroponics	5%	15948.9 m <sup>2</sup>

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## Fruits

Crops grown	Suitable methods	Growth percentage	Area
Grapes	Hydroponics, aeroponics	3%	9569.34 m <sup>2</sup>
Corn	Hydroponics	5%	15948.9 m <sup>2</sup>
Strawberry	Hydroponics	5%	15948.9 m <sup>2</sup>
Blue berries	Hydroponics	2%	6379.56 m <sup>2</sup>

## ANIMAL HUSBANDRY:

Animals produce the products that are useful for body growth and development of human beings. INGRESS has less animal population because, there is less amount of oxygen in space and also the land in agricultural torus is not very suitable. So, the animals in animal husbandry are of different types and in those types they are different categories. For the storage of these products we will use a separate storage house called barn.

This animal husbandry occupies about 35% agricultural torus. That is about 223284.6 m<sup>2</sup>. the waste which comes from the animals in this place is used as the manure for the crops in agriculture.

## POULTRY:

In poultry there are only two types of birds and 600 in numbers that is 300 in each. These birds are egg producing and in same way the meat producing birds. These birds produce about 159000 eggs per year i.e. each bird produces 280 eggs per year. Poultry area takes about 15% of agricultural torus i.e. 478467m<sup>2</sup>. The table shows their growth and population:

Poultry animals	Number of animals	Percentage	area
Hens[hybrid]	300	60%	287080.2
Duck[white layer breed]	300	40%	191386.8

### Hens [hybrid]:

These hens produce 280 eggs per year. These are the hybrid hens which eat nuts and micro organisms in soil. These birds are breaded at the age of 22 weeks. These hens are eggs and meat producing hens.

### Duck [white layer breed]:

The ducks are of white layer breed category. This bird produces from 250 to 300 eggs per year. It weighs up to 45 kg and its feathers are useful for making beds and pillows. Its egg weighs 75 grams to 80grams and they also produce meat. They are breaded at the age of 25weeks.

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## CATTLE:

In this dairy cattle area "INGRESS" is going to grow three types of animals. In these three types each animal is of different categories. This cattle area takes about 20% of agriculture i.e. 637956m<sup>2</sup>. These animals produce milk and wool. These animals are called as cattle diary animals. The animals in this area are cows, sheep and goats.

We need milk for growth and development of our body. Milk is also called beneficial fluid or liquid. Because, it helps humans in many ways like in loosing fat from our body and other activities. Whereas coming to the goat, it is beneficial in both the ways; by providing wool and meat. But the sheep produce only wool, but in huge amount. So, INGRESS is going to take different categories in the three different animals.

## COWS [HOLSTEIN]:

This cow is taken as the best milk producing cows because; this category cow produces about 25 – 28 liters of milk. This cow weights about 1,500 pounds and 58 inches in height. These cows get matured at the age of 11 – 14 months.

## GOATS [ANGORA, ALPINE]:

Angora and alpine goat are of same family but different categories. The Angora goat is a wool producing animal. It produces about 3.6 kg to 6.8 kg of wool per year. These goats will be less in number. Alpine is taken as the benefitting goat because it produces both milk and meat. These goats get matured at the age of 4 – 8 months. These goats produce 3.7 – 7.5 liters of milk a day.

## SHEEP [PEPPIN MERINO]:

This sheep produces up to 18 kg of wool per year. These sheep are from the merino family. The wool is of 20 - 23 microns. In this 18 kg of wool 8 kg of wool is pure and remaining is grease. This sheep get matured at the age of 6 – 8 months.

Cattle animals	Number of animals	Percentage	Ground provision
Holstein [cow]	550	50%	318978m <sup>2</sup>
Angora [goat]	150	10%	63795.6m <sup>2</sup>
Alpine [goat]	250	10%	63795.6m <sup>2</sup>
Sheep [peppin merino]	250	30%	191386.8m <sup>2</sup>

## STORAGE IN AGRICULTURAL TORUS:

After the growth of crops we have to harvest them before they get decayed and then store them in a place where the temperature supports the crops. The storage area contains of two different houses where the crops and the products from animal husbandry are stored. Silo is the agricultural products storage house and the barn is the storage house to store the products that are produced by animals. The storage area takes up to 10% of agricultural torus i.e. 63795.6m<sup>2</sup>.

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## CONTROL DECK:

We need to move the products produced in agricultural torus to different areas. Like oxygen produced by plants should be transferred to residential torus, raw materials produced in animal husbandry should be moved to storage house and the harvested crops should also be moved to storage house before they get spoiled. So, to control all these machineries we need workers so that the machineries will be controlled and these workers do the work that could not be done by machines. This control room occupies about 5% of area in agricultural torus i.e.  $31879.8\text{m}^2$ . It also controls the machinery and the water supply to the plants in the different agricultural process.

## 5.4 Water

Water is the basic unit of life. It helps in digestion of food in a human body. A human body is made of 70% water. A normal man should consume 3.7 liters of water daily. The composition of water in our internal body parts are:

Internal body parts	Percentage
Blood	70%
Lungs	20%
Brain	10%

Due to all the work done by a man in a day, he loses about  $\frac{1}{2}$  liter water in the form of sweat. So, we are going to take easy steps to conserve water in space and give a comfortable life for the residents. The water levels will be different for each torus. We will try to save every drop of water in many different ways.

Apart from that, we would use the available water nearly from 5 to 6 years. After this duration we are going to extract water from other planets like mars. Mars mostly it contains 18% to 19% of  $\text{H}_2\text{O}$  in it. We would also extract a huge amount of water from asteroids such as 3671 Dionysus.

## EXTRACTION OF WATER CHEMICALLY:

The water which would be transported from earth will not be sufficient. So, we would extract water chemically by using different methods.

## EXTRACTING WATER FROM ILMENITE:

Ilmenite is made up of 42% oxygen. INGRESS is going to obtain water from lunar soil by applying hydrogen reduction process to ilmenite.

The following reaction shows the reaction after applying hydrogen reduction process to ilmenite.



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By using this method, we can extract water very easily.

## WATER MANAGEMENT:

Water is very precious in space. Therefore, it would be conserved. We already have different methods to recycle water, INGRESS would use all the methods which are suitable to recycle and conserve water. We would also recycle water which will be obtained in the form of human wastage. INGRESS would also use water to create artificial seasons. So, after the moisture is released into the torus it would eventually be absorbed and recycled. We would also use other methods such as ilmenite mining and asteroid mining.

## WATER FROM SEWAGE TREATMENT:

The conservation of water during sewage treatment will be done below the residential buildings. The bathrooms have a normal floor design with tiles and the human excrete i.e. human waste will be sent through the sewage pipes and they will later be pushed into the sewage treatment machine.

## WATER MANAGEMENT:



The sweat of the residents is absorbed by a machine in the form of a gun that absorbs sweat from their body. The gun takes off the sweat from the people and stores in a can with a capacity of 2 liters. This gun will be very helpful due to its absorption technique. In this way, the sweat released by the residents will be collected. It would be purified later.

Figure 29 . Sweat absorbing unit

## WATER STOAGE:

We have designed a huge container which can store up to 520 liters of water. These containers will be placed in each colony. These containers will be used to supply water to almost 105 families. The water which will be treated and purified will be sent to these containers to store the water.



Figure 30 . Water storage

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## 5.5 ELECTRICITY

Electricity is essential to run the settlement. We need electricity to run all the machinery in INGRESS as well. If electricity is unavailable, the whole settlement would not be possible at all.

### PHOTO VOLTAIC SOLAR PANELS:

Photo voltaic solar panels are used in our system. These panels are equipped on the torus, central rod, docking port and other exterior parts. Quantum dots would be placed on the panels because these quantum dots are very small semi conductor particles. They are main theme in nanotechnology; they have the ability to tune the band gap making a quantum dot desirable for solar panels. These quantum dots have the ability to make infrared radiant energy as well.

VACANT's (vertically aligned carbon nano tubes) would be placed on the edges of the solar cells to increase the area for capturing the light. It also makes the solar panels strong. Efficiency to capture light is 96% in these solar panels. These solar panels would be used in internal transportation and external transportation mechanisms as well.

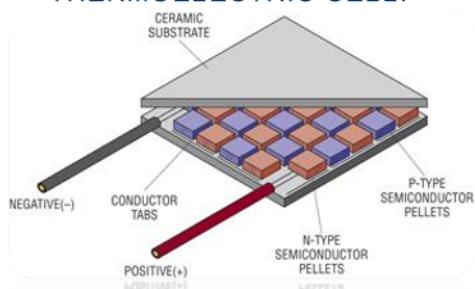
### TRANSPARENT SOLAR PANELS

Transparent solar panels will be equipped on illumination windows. These solar panels do not contain quantum dots. These solar panels have less efficiency than photo voltaic solar panels. Efficiency of these solar is 72%. These are also used on other mechanisms which run with the help of solar panels. These also protect the residents from UV rays and IR radiations. These are transparent in nature.

### ELECTRICITY TRANSMISSION BY PHOTO VOLTAICS:

Photo voltaic energy transmitter would be used for generating electricity. Thrusters below the machine will set the transmitter in an angle such that sunlight falls on mirror. The sunrays will be concentrated at one point with the help of the mirrors. After passing through the photovoltaic's and transmission antenna, the ray will be transformed into a power beam and reach the settlement. This is one of the best ways for obtaining more electricity.

### THERMOELECTRIC CELL:



Converting heat energy into electric energy is known as thermo electricity. In our settlement, the heat energy released by the sun would be converted into electricity. On the earth, we will be using large scale industries to generate electricity from heat. But in INGRESS, we would use thermo-electric cells. These cells are 80%-85% efficient. We can also reduce the temperature inside the settlement using these cells.

Figure 31. Thermoelectric cell

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## SOUND TO ELECTRICITY CONVERTER:



Figure 32 . sound to electricity converter

These are mainly used for transportation; these converters would also be used in mobile phones and other machinery. These converters are used in transportation roads and other places. These linked to each other with the help of connection cable. The electric energy will be stored in the electrical chambers which are located in the common sides of residential torus. This could be used to generate lot of electricity due to the rapid growth of sound pollution.

Sound pollution is one of the major pollutions because it could reduce the lifespan of humans. Our settlement could also be affected by sound pollution. For reducing this pollution, we will be using a converter which converts sound energy into electrical energy. By using this method, we would gain electrical energy and it even helps us to reduce the sound pollution in INGRESS.



Figure 33 . Structure of the sound to electricity converter

## SOLAR POWER GENERATOR:

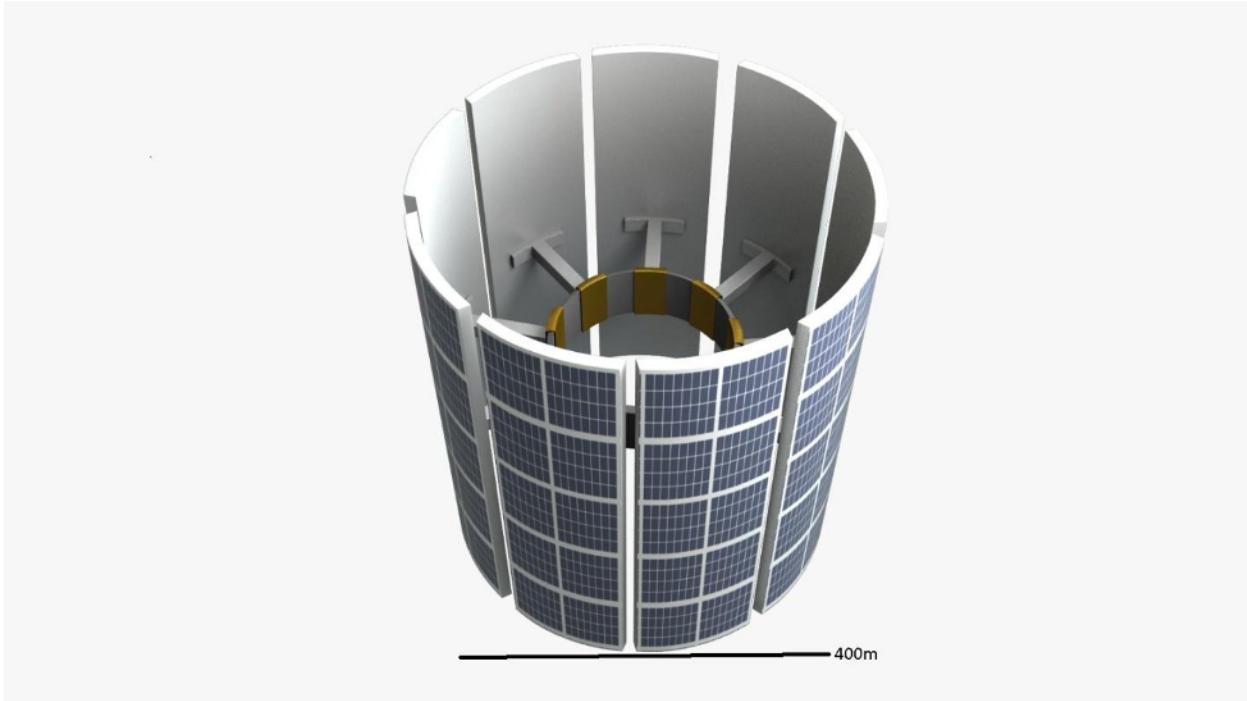


Figure 34 . Picture of the Solar Power Generator

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This is used for generating additional solar power. It is satellite with a battery equipped with solar panels around it. In the middle of the satellite, a battery is connected to store the solar power. Outer space heavy transportation pod is used to change the batteries. Radius of the spacecraft is 200m and the radius of the battery is 100m.

## 5.6 WASTE MANAGEMENT

There is one thing left out after every industrial process. That is considered as waste. But after the recycling process it is considered as raw material. The waste materials produced by the industries come in the form of small particles. So, these materials are separated and recycled by using either methods of separating and recycling methods. There are different types of trash to be recycled such as plastic, metals, dung, paper, water, sweat etc.

### INDUSTRIAL WASTE MANAGEMENT:

Industrial waste materials like metals of different sizes are dumped into a big storage container. Those metals will be sent to a machine called eddy's current separator that separates ferrous and non – ferrous metals by magnetic separator. The metals would later be separated and stored in different containers. After division, the material will be send to the industries again.

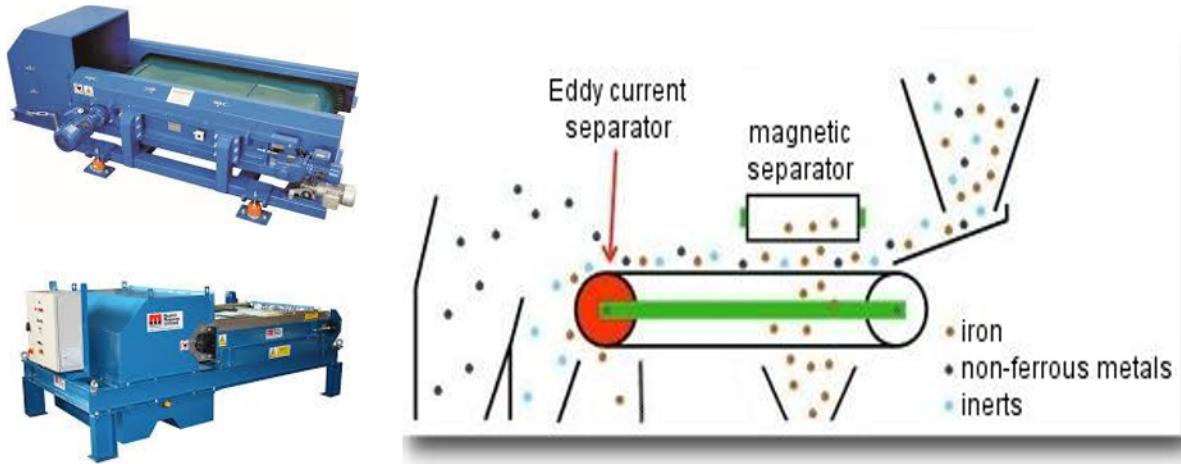


Figure 35 . The Eddy's current separator

### RESIDENTIAL WASTE MANAGEMENT:

#### SEWAGE TREATMENT:

The human waste is divided into solid waste and liquid waste. This dividing process will be done before the waste materials enter the sewage treatment pipe. After the separation, it goes on flowing towards the bar screen where the other solid waste stops and the liquid waste continues this process till it reaches the sewage tank where the liquid waste would be purified. The sewage tank is divided into two parts; one is the evaporator and the other is waste removal part. The water is evaporated and salt is extracted, the

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waste will be removed later. But only 80% of waste will be removed and the remaining 18.7% is removed by the electric filters while the remaining 1.3% is evaporated in the evaporation part. In this process the human waste is recycled into pure water.

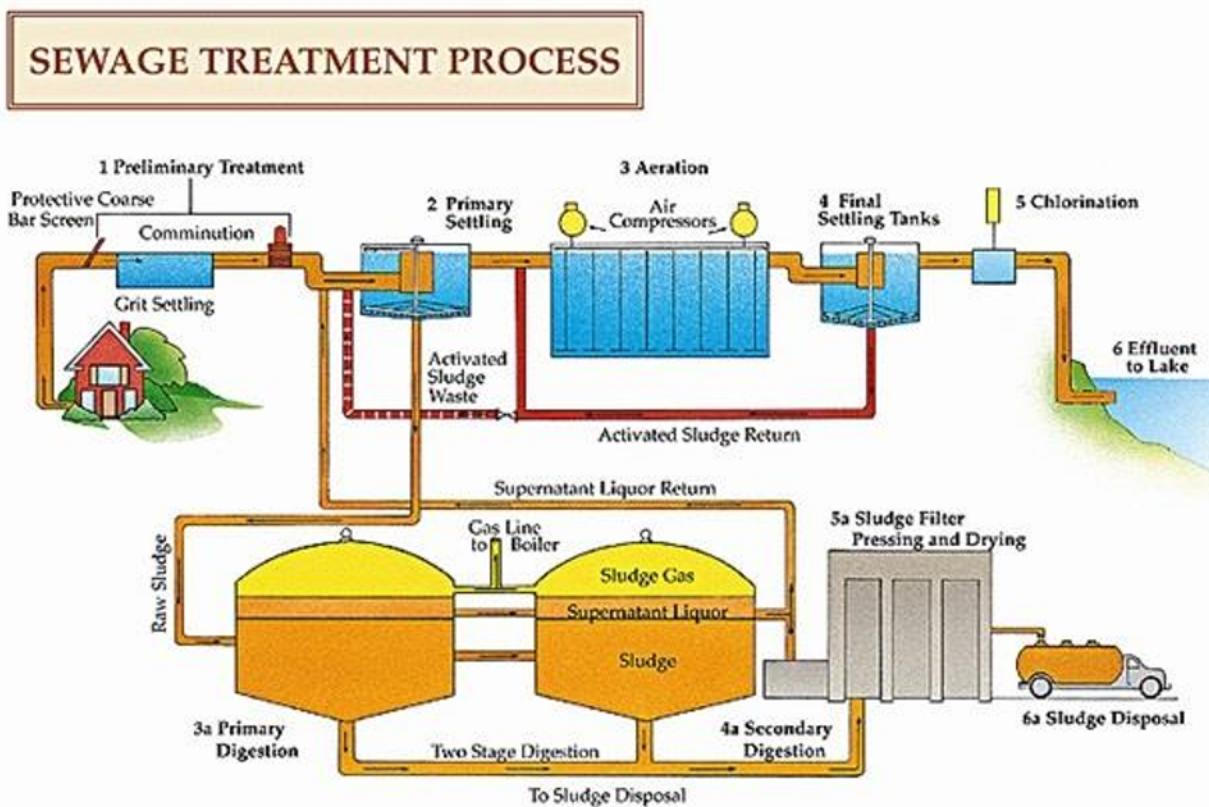


Figure 36 . Sewage treatment process

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## 6 SPACE DEBRIS

On October 4 1957, the first artificial earth satellite named as sputnik-1 was launched. This inspired people all over the world. After sputnik -1 stopped functioning, it burned up on 4 January 1958 by entering into the earth's atmosphere. The other two satellites launched after sputnik-1 [sputnik-2 and explorer-1] also reentered the earth's atmosphere and got burned up. But later, the fourth artificial satellite which was launched on 1958[known as vanguard-1] lost communication with earth in 1964. Although it came out of

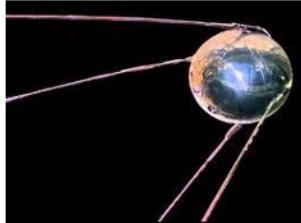


Figure 39 . Vanguard-1

operation in 1964, it remains in the earth's orbit. It is said to continue to orbit the earth for another 200 years or more. This is what we now call space debris [or] space junk. Vanguard 1 is known as the oldest piece of space junk that orbits the earth. Space debris is the collection of defunct man-made objects in space such as old satellites, lost materials in space, fragments from collisions and spent rocket stage. Space debris poses a great threat to human activity in space. This problem has started in the 1960's and it has been exponentially growing ever since. If not taken care of, it is going to reach a stage where it cannot be stopped; it would be pointless to worry about space debris at a

time like that. As of July 2013, more than 170 million debris smaller than 1cm, about 6,70,000 debris from 1cm to 10cm, and around 29,000 larger debris were estimated to be in the earth's orbit by the ESA. Debris varies in size and shape. Debris with a length of 1cm can produce damage like TNT. Debris normally travels with speed between 3km and 12km. Debris could collide with operational space ships and satellites which would generate more debris, causing a chain reaction. This is known as the Kessler syndrome. Several major events such as the 2009 collision between Iridium 33 and cosmos 2257 took place in past year which generated millions of debris. This proved that humans do not care about space debris.

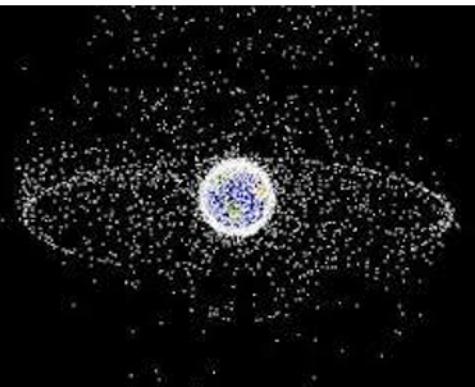


Figure 37 . Space debris around the earth

### 6.1 PROTECTION.

As of 2017, there are more than 38,660 well-documented meteorite finds. Every year, thousands of meteorites enter into the earth atmosphere, most of them burning up within their few seconds of entry. Meteorites travel with various velocities. Some of them travel with a few km/s whereas some of them travel with tens of km/s. Meteorites can be very dangerous like space debris. There are millions of space debris orbiting the earth. They all travel with speeds up to 8km/s which is 20 times faster than a 9mm bullet. They are fast enough to damage a satellite or a spacecraft. The growth of debris is increasing the potential danger to all spacecraft including the International Space Station (ISS). To ensure safety from space junk, a shield would be built around the outer layers of INGRESS. Space craft stations [such as ISS] have been using "whipple shield" mechanism as a protection from space debris and meteoroids. The Whipple consists of two layers. One of them is bumper plate while the other is rear wall. The bumper plate is used to absorb the projectile impact and disintegrate it while the rare walls are used to absorb the remaining impact. The Whipple shield is a great mechanism invented by Fred Whipple. It

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could be used in INGRESS. However, the Whipple shield can't endure continuous impact and it is vulnerable to large bodies. It also increases the thickness of the spacecraft walls, which is not a very good idea. We could use the stuffed Whipple shield as an alternative because it is far better than the normal Whipple shield. The only difference is that it has an additional layer of Nextel and Kevlar between the layers. But we have chosen a better shield for INGRESS. Mesh double bumper shield (MDB) would be used in INGRESS. The MDB shield provides a better shielding performance than the stuffed and normal Whipple shields. The MDB shield is more efficient and can endure continuous impacts. It even saves more than 50% weight. The MDB shield is mass-efficient and cost efficient. It consists of four layers; the first one would be the mesh bumper which absorbs the projectile impact, disintegrate it and defuse the fragments to a wider angle. The second layer (bumper plate) functions the same as mesh bumper. The fabric layer and rear wall are used as backup layers which would absorb the remaining impact and stop the particle.



Mesh Double Bumper Shield

The Mesh Double Bumper Shield consists of a double layer bumper of aluminum mesh, followed by an aluminum rearwall.

## 6.2 MANAGEMENT

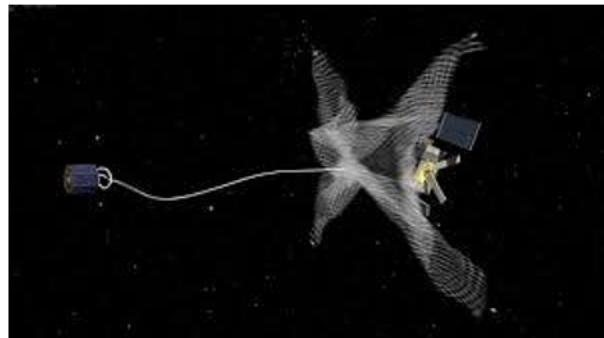
Since space debris poses a major threat to human kind as well as our space settlement, certain measures must be taken to wipe out space debris. If space debris is disregarded, it can cause major problems in future. INGRESS would give importance for cleaning space debris. INGRESS is located in the L.E.O which makes it vulnerable to much space debris because it is not safe to orbit a place crowded with space debris. The shield mechanism would protect INGRESS from space debris, but space debris will keep on increasing and it will reach a stage where we can't protect our settlement with the current debris shield. This proves that we need to eliminate debris from space. '*What goes up must come down*', space debris orbiting the earth will eventually enter the earth's atmosphere at some point. But in order for that to happen, we have to wait for several hundreds of years, but until then, space debris keeps on increasing and damaging more satellites and space craft's.

Scientists have noticed the space debris problem and they started seeking for solutions to clean space debris. Some organizations have come up with ideas to clean space debris. Some of their plans are listed below:

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## e.Deorbit mission:



e.Deorbit is a space debris removal mission planned by the European Space Agency (ESA). This launch is planned for 2021 on board VEGA [rocket]. It was first proposed in 2014. It would seek satellite debris in a polar orbit at an altitude between 800 and 1000km and deorbit them. It would be equipped with capture

Figure 40 . e.Deorbit

mechanisms such as robotic arms and giant nets.

## ADVANTAGES:

- ✚ A quick solution for the space debris problem
- ✚ It can gather more than one piece of junk.

## DISADVANTAGES:

- ✚ It could generate more debris
- ✚ Works within a small region
- ✚ Economically inefficient

## CLEAN SPACE ONE:



Clean space one is a technology demonstration satellite. It is proposed by École Polytechnique Fédérale de Lausanne (EPFL). It is meant to grab the Swiss cube launched by Switzerland and burn it in the atmosphere. It would drag the nano satellite [Swiss cube] into the earth's atmosphere where the device and the junk both burnout. It is equipped with a claw designed to grab the Swiss cube.

Figure 41 . Clean Space One

## ADVANTAGES:

- ✚ Easy solution for the problem

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## DISADVANTAGES:

- ✚ The device is not reusable
- ✚ It is developed to deorbit the Swiss cube only
- ✚ It might create more debris
- ✚ It pollutes the earth's atmosphere
- ✚ It can catch only one piece of junk
- ✚ Economically inefficient

## SLING-SAT:



Sling-sat is a space sweeper designed by the Texas A & M University. It is a sling shot device which absorbs the impact of the space debris, and then use the momentum to sail to its next target. It would redirect and launch the particle into the earth's atmosphere where the debris would burn up.

Figure 42 . Sling-Sat

## ADVANTAGES:

- ✚ Probably the best idea for space debris cleaning.
- ✚ Cost efficient
- ✚ It can tackle multiple space debris
- ✚ Saves a lot of fuel

## DISADVANTAGES:

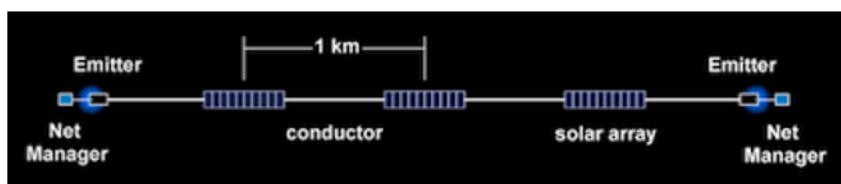
- ✚ It might create more debris if it misses the target
- ✚ Pollutes the earth's atmosphere

## EDDE (ELECTRODYNAMIC DEBRIS ELIMINATOR):

The electrodynamic debris eliminator is proposed by star technology

and research. It is a spacecraft which would capture orbital debris in a huge net and drag the junk down of harm's way. The EDDE would draw power from the sun and earth's magnetic field to move. It doesn't rely on costly chemical propellant which would actually help in keeping

Figure 43 . Electrodynamic Debris Eliminator



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the cost down.

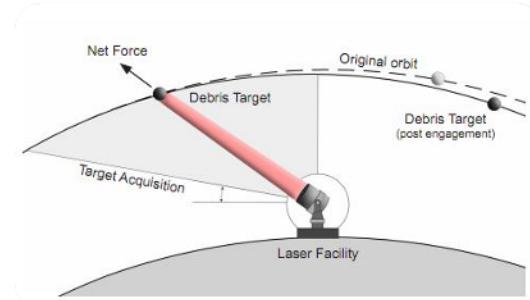
## ADVANTAGES:

- ⊕ Fast and easy solution for the problem
- ⊕ Doesn't burn up with the debris

## DISADVANTAGES:

- ⊕ Pollutes the earth's atmosphere

## LASER BROOM:



Laser broom is a laser beam-powered propulsion system proposed by NASA. The laser will sweep the space debris out of the path of other artificial satellites. It would also heat one side of the piece of junk to change its course and make it drop into the atmosphere. This is thought to cost \$1,000,000.

Figure 44 . Laser Broom

## ADVANTAGES:

- ⊕ Cheap
- ⊕ It can be manufactured sooner than any other project and solve the problem very quickly

## DISADVANTAGES:

- ⊕ Pollutes the earth's atmosphere
- ⊕ Requires high tracking technology
- ⊕ It can cause serious problems if it even makes a slight mistake

There are more projects proposed by other organizations.

Some of them are:

- ⊕ Electric tether – by JAXA
- ⊕ Giant fishing nets – china
- ⊕ Tamu sweeper – Texas A&M university
- ⊕ Cube sail etc.

But there is a common disadvantage for these projects. All of them intend to deorbit the debris and drag them into the atmosphere which would cause the material to burn up. But some debris could crash into the earth, causing very great problems. Burning up debris in the atmosphere causes pollution, which is not good for the earth. These methods do not allow us to recycle the debris; they would only waste the

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valuable material by burning it up. So INGRESS would have mechanism which would retrieve the debris to the settlement. The material would be sent to the industrial torus where it would be recycled.

## THE INGRESS SPACE CLEANER CUBE (ISCC)

After looking at all these models and ideas, we have come to a decision to design a space cleaner for INGRESS. This would enable us to clean up space debris very fast. Our space cleaner would capture the debris and carry it to INGRESS. After the space debris is brought to the settlement, it would be sent to the industrial torus where it would be recycled. Our space cleaner has the design of a cube. It would use electron propulsion to travel in space. We have chosen electric propulsion instead of ion propulsion and chemical boosters because it requires very little amount of mass and runs with electricity. Unlike the chemical propulsion, it isn't limited in energy. Electron propulsion is very suitable for low-thrust, long-duration applications of spacecrafts. Electron propulsion is very suitable for the ISCC. The ISCC's main objective is to collect and bring all the space debris to the settlement. There are 3-types of space cubes, but all of them share a single sector (the cube). The ISCC would capture space debris and move along with the space debris until it reaches the settlement.

### SPACE CUBE:

The space cube is the major and common part for all the ISCC models. The space cube is a small cubical spacecraft with 4 sides equipped with solar panels, one side equipped with the electron propulsion unit, and the other one would be the functional unit.

### TYPE-X:



Type-X ISCC is to clean non functional satellites and small debris. It is equipped with giant fishing nets (china) to capture debris. It grabs the satellite and brings it back to the settlement and immediately leaves for the next target.

Figure 45 . Type-X ISCC

### TYPE-Y:

TYPE-Y ISCC would get very close to the material (space junk) and grab it with its robotic arms and carries it to the settlement. The robotic arms would grab hold of any stable component of the satellite and travel with it to the settlement. This would be used clean space debris bigger than 10cm.



Figure 46 . Type-Y ISCC

## **INGRESS**

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### **TYPE-Z:**

TYPE-Z is the final type of space cube. It is equipped with two other space cleaners which would also run on electric propulsion. These space cleaners are used to capture space debris smaller than 1cm and store them inside. After they get filled, the ISCC along with the cleaners would take them to the settlement.

# INGRESS

## 7. INFRASTRUCTURE AND OPERATIONS.

### 7.1 ILLUMINATION

The space is a vast place filled with darkness. But truly, it is in darkness one finds light, and we found a light for INGRESS as well.

*"Give light, and the darkness will disappear itself"*

-Desiderius Erasmus.

Illumination plays a vital role in the human life. In order to make the residents feel like they are in earth, an illumination which resembles the earth is necessary. INGRESS would provide an illumination which would make the residents feel it as their home. For this we have chosen the source of illumination as Light Emitting Diode (LED). Different kinds of LED's would be used to light the ceiling and houses of the city.

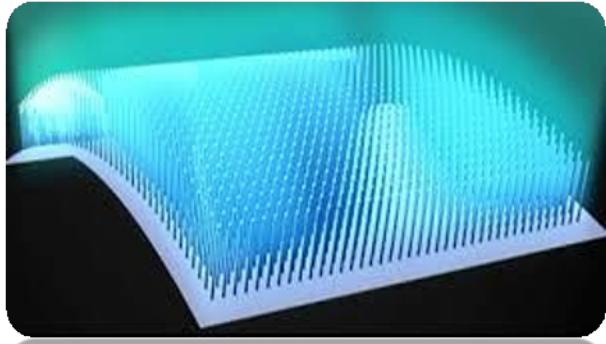


Figure 47 . Organic LED

INGRESS would use the technology of PI-LED. The research says that it can be used to generate cold-white light and warm-light. Including PI-LED, other LED's such as plasma bulbs, organic LED, Halogen Metal iodine bulbs etc will be used to illuminate different parts of the settlement. Poly carbon lexane sheets and change the color of the light to make people feel like they are in earth. The Day and night cycles are also essential to make people comfortable. If any damages or repairs occur, the night would be best time to fit it up.

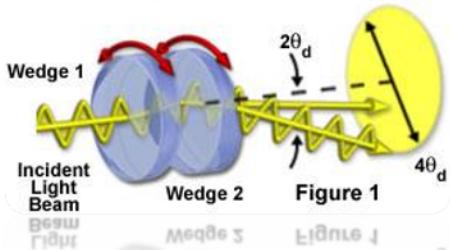
#### HELIOSTAT:

A heliostat is a device which can be used to reflect sunlight towards a predetermined target. INGRESS shall use numerous heliostats placed on the segments to reflect sunlight and illuminate the insides of structure.



Figure 48 . Several Heliostats placed to reflect sunlight towards a common target

#### Beam Steering by Wedge Prisms



#### WEDGE PRISM:

Wedge prisms are our secondary reflectors. Wedge prism's are usually of an angle of 3 degrees or less. These prisms would be used to deflect sunlight by a fixed angle. We would utilize these

Figure 49 . Beam steering by wedge prisms

# INGRESS

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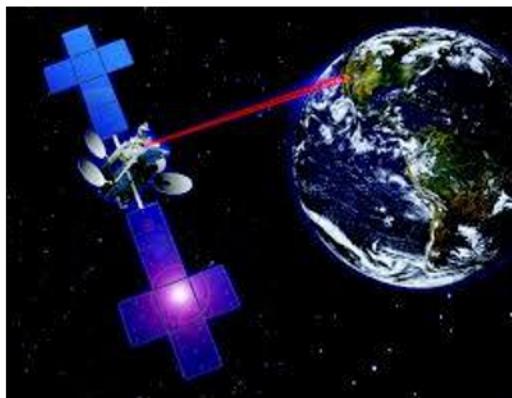
prisms for beam steering. This would also be helpful to illuminate the infrastructure.

## 7.2 COMMUNICATION

### COMMUNICATION IN DEEP SPACE:

Communicating is done in our daily life. Without communication, the humans would have suffered a lot. We have created several languages and started communicating in the ancient period. The communications that we now use are social networks and telecommunications. Technology has increased from the pony express to fiber-optic communications. But this is not the end for anything; we can proceed forward and develop communications even faster than the speed of light. But communication in space is not as simple as how we communicate on earth. It requires precise knowledge and hard work to communicate over hundreds and thousands of kilometers for the earth. INGRESS needs to communicate with the earth, lunar base and other objects. For this, we had many options to choose from. We have mainly chosen 4 communication methods for INGRESS. But we had to choose the best out of the best. The communication methods which were best suitable for INGRESS are given below.

#### LASER COMMUNICATION:



It is scientifically proven that light can carry information. Laser emits a light through light amplification based on stimulated emission of radiation. These light rays are the most reliable source of communication in deep space. Laser communication can be achieved in space. It can transfer information over thousands of miles in space. Lasers have high data carrying capacity.

Figure 50 . Satellite using laser communication

#### ADVANTAGES:

- ⊕ High data carrying capacity
- ⊕ Can be used for large distance space communication.

#### DISADVANTAGES:

- ⊕ Harmful if collided with the settlement.
- ⊕ Requires complex maintenance.
- ⊕ Visible
- ⊕ Harmful to humans
- ⊕ Low transmission speeds
- ⊕ Gets interrupted or stopped by various factors which would lead to loss of valuable data.

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## NEUTRINO COMMUNICATION:

Neutrinos are tiny, electrically neutral and extremely weak interacting particles which can pass through almost anything. These ghostly particles are faintly affected by gravity only. It interacts with nothing in the virtual world. A neutrino could easily pass through 1000-light years of lead, proving nothing can get in its way. These neutrinos can also be used for transfer of data in space. This enables us to perfectly communicate in space. These neutrinos are not harmful for Human beings or any other material.

### ADVANTAGES:

- ⊕ Higher transmission speeds of light
- ⊕ No deflection at all
- ⊕ Can penetrate through almost anything, keeping the data safe.
- ⊕ Does not cause any harm.

### DISADVANTAGES:

- ⊕ Moderate data carrying capacity
- ⊕ The main problem in neutrino based communication is that if they could pass through almost anything, they could pass straight through any detector .Hence; detection of these particles is extremely difficult, leaving the communication process incomplete.

## QUANTUM COMMUNICATION:

Quantum communication may be possible with quantum entanglement. Quantum entanglement is the entanglement of 2 quantum states such as photons. The behavior of one particle says something about the other. We could separate the two articles all the way across the galaxy, and still know the behavior of one by looking at the behavior of the other .This works on Instantaneous data transmission, which means it doesn't even require traveling in space. This would actually beat the speed of light, like it was nothing. But we are not sure that it is actually possible to send information through quantum entanglement. This is the main reason why we didn't choose quantum communication.

## X-RAY COMMUNICATION:

We know that light forms like radio waves and lasers can carry data. Fiber-optic telecommunications also rely on visible and near infrared light. X-rays are a form of electromagnetic radiation. X-rays could be used to transmit data at high rates over huge distances in space. X-rays could transmit giga bytes of data per second using minimal power. Our current technology couldn't achieve this, But it would be developed in the near future. X-ray communication is said to have the potential to provide high-data transmission rates at low power over vast distances. It could penetrate through the RF shielding on the ground [Ref: NASA].

### ADVANTAGES:

- ⊕ carries large amount of data using little power
- ⊕ penetrates through the RF shielding on the ground
- ⊕ Can travel long distances with little interruption

### DISADVANTAGE:

# INGRESS

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- harmful to humans [could cause cancer]

## OUR DECISION:

We have come to a conclusion that x-ray communication technology would be used in INGRESS. We have chosen this method because we thought that it would be the best for our project.

As INGRESS is located in LEO, X-ray communication would enable it to send large amount of information in a very short time. It could make INGRESS stay connected to the earth and the lunar base. The reasons why we didn't choose the other three methods are given below.

LASER communication: Laser communication couldn't beat x-ray communication in a lot of ways including data carrying capacity and penetration power.

NEUTRINO communication: It is definitely better than any other x-ray communication but the problem is; If neutrinos can pass through any virtual objects, It would be very difficult to detect them.

QUANTUM communication: Quantum communication would be the best type of communication ever introduced. But we are not sure that it is actually possible.

## 7.3 TRANSPORT.

Transportation plays a great role in INGRESS. To move from one place to another place, we need transportation. The concept of transportation is divided into two parts in INGRESS. One is internal transportation while the other one is external transportation.

### TRANSPORTATION IN THE CENTRAL ROD:

Transportation done in the central rod is very important because it is connected to all the major components like the segments, tori, docking port, communication centre. So, we need an easy transportation in the central rod to access all these major sectors. INGRESS will be using elevators for transportation in the central rod. There are a total of four elevators in the central rod. Three types of elevator designs are used for these elevators. Details about the designs are listed below.

#### SPACE ELEVATOR DESIGN: 1

This elevator is used for transporting the residents. Rotatory system has been implemented in this as in the project Globen sky view. Rotatory system is used while taking turns in the central rod. This will be in the shape of cylinder. There are two such elevators in central rod with this design. It has capacity of 9 persons. It runs with a speed of 10m/s.

## INGRESS

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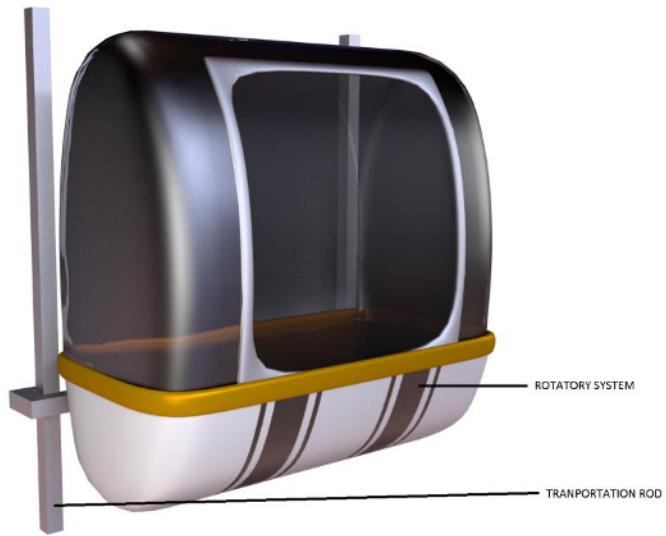


Figure 51 . Picture of the elevator design-1

### SPACE ELEVATOR DESIGN: 2

Space elevator design 2 is used for transportation of goods. This elevator could be used to carry machinery and others material. This elevator also has a Rotatory system resembling the other design. This will be in the shape of sphere. It can carry a weight of 4.5 tons with a speed of 5m/s.

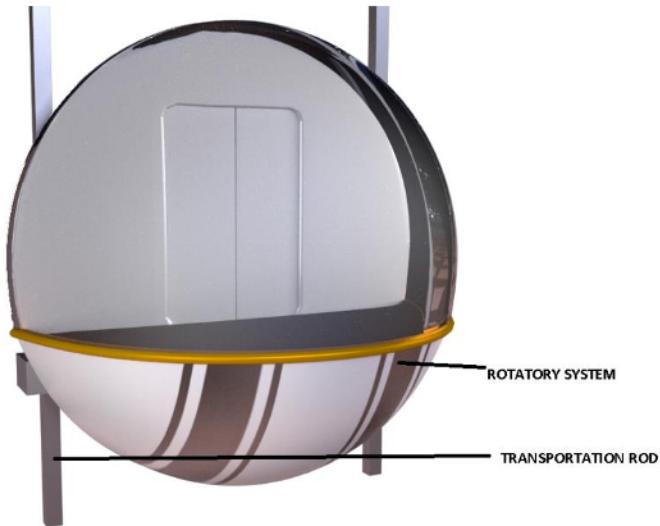


Figure 52 . Picture of the elevator design-2

# INGRESS

## SPACE ELEVATOR DESIGN: 3

Space elevator design 3 is used in case of emergencies. The design will be same as space elevator design 1, but in different size. It has the capacity to hold 1-5members. It moves with a speed of 14m/s.

## INTERNAL TRANSPORTATION:

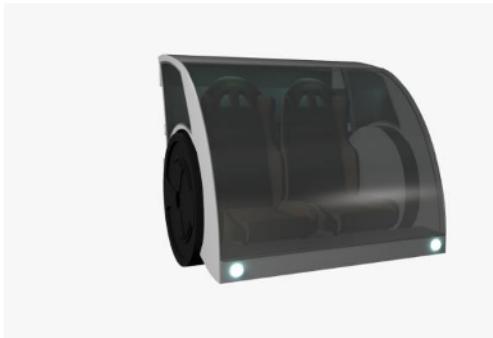


Figure 54 . Front view of the IOMP

settlements. The receiver in the car and the coil will extract electricity from the transmitter which is present inside the roads of the settlements. After the extraction of electricity it will store the electricity in the battery which is built in the vehicle. If the charging in the vehicle is low the driver would change to charging roads so that they can travel while car gets charged. This runs with a maximum speed of 30km/h. It is used for short distance transport and two members can travel in it. We can expand it by using the mod (you can see it at the back at the car) option which can also be used for extension of the car's features.

This is the extension for transportation pod. This has extension battery, engine and some other features. By using this method the IOMP can increase its features like speed etc. SOLAR panels are immersed at the top of transportation pod and sound to electricity converter is installed on the wheels of IOMP.

This is the transportation which is done inside a torus or a segment by the residents. We gave importance to internal transportation and developed two new mechanisms for this. The first mechanism we have developed is a special vehicle which can be used in many ways. We named this mechanism as the Ingress Omni Mod Pod (IOMP) because the name is suitable for it. This transport pod is used to travel short distances. It is a two wheeler. This pod

runs with the help of electricity. It consists of a receiver which receives electricity from the transmitter which is present inside the roads of the

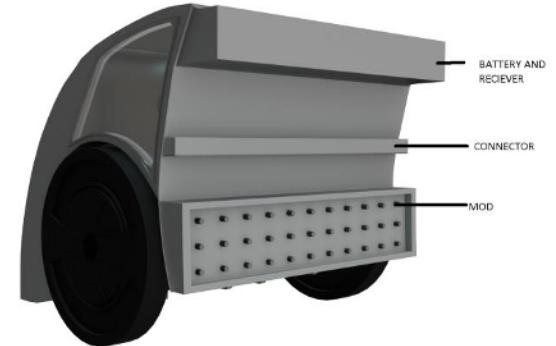


Figure 53 . Back view of the IOMP

## HYPER WALL PYTHON:

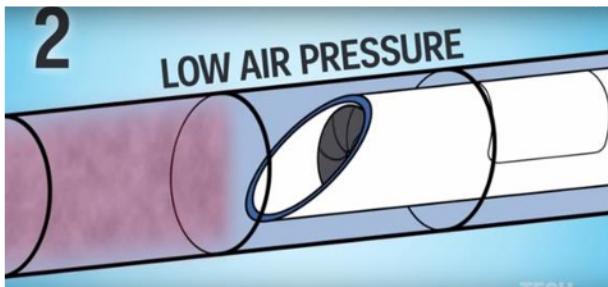


Figure 55 . Hyper Wall Python

This hyper wall python is vacuum based hyper loop which would be constructed to the wall of the torus. It will be constructed inside the tube which would be connected to wall of the torus. These hyper loops will contain 4 coaches. We would construct four stations at the centers of each colony. Lights are attached

## INGRESS

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below the tube because the light which is coming by illumination windows and the light coming from the top of the torus will be stopped by these hyper walls. This hyper loop works with vacuum by creating low air pressure at forward. Solar panels will be constructed below the illumination windows.

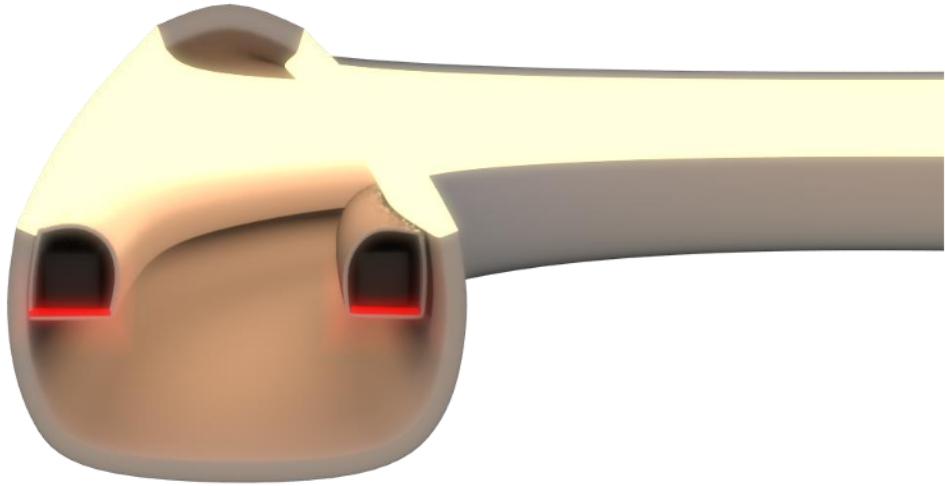


Figure 56 . Placement of the H.W Python inside the torus

### EXTERNAL TRANSPORT:

External Transportation is very important because this involves the transportation of central rod, tori and other materials from the earth to LEO.

### OUTER SPACE HEAVY TRANSPORTATION POD:

This machine is used for transportation of central rod, docking port and tori. This has arms to catch component. Control deck is used for operating the pod and communication centre is built in this because it is very necessary to communicate with other pods and system. The area is extendable up to 2.8km. This is also used for replacing the battery in solar power generator. 6 pods are used for transportation of central rods, 4 pods are used for transporting a torus 1pod for transporting docking port, 1 pod for batteries. We need 6 pods for transportation and 2 pods are for emergency.

### EVACUATION PODS:

If any disaster or malfunctions occur in the settlement or lunar base, we would need the help of evacuation pods to send the residents safely to earth. It needs high speed, so we are going to use VASIMR thrusting technology. By using this we can go with a top speed of 40km/s. It would transport the residents to earth safely.

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## 7.4 RESEARCH

Humans require development, humans also have the curiosity to find about new things and invent new stuff. But for this research is required. Research would be one of the main operations in INGRESS. Different kinds of research labs would be located in different sectors all over INGRESS. The main research facility will be located in the SEGMENT 1. Other research labs would be located in the residential, agriculture, and industrial torus. Different labs would be placed in different locations according to their purpose.

The different gravity levels in our settlement can assist us with the various kinds of researches. The various types of researches that would be carried on INGRESS are listed as follows.

### MAIN RESEARCH LAB:

The main research lab would be located in SEGMENT 1 where all kinds of research will be done, but in a limited manner. This part has conference rooms where scientists can gather and share their views. The main research lab would act as the headquarters for the research sector in INGRESS.

### ASTRONOMY LABS:

These labs are located in the SEGMENT1 and residential torus. In these labs, research related to celestial bodies such as asteroids, meteoroids, planets and stars will be conducted.

### PHARMACEUTICAL LABS:

These labs are situated in the agricultural area and SEGMENT1. A pharmaceutical lab performs research on the human body. These labs would concentrate on developing medical drugs.

### COMMUNICATION RESEARCH LABS:

These labs would be placed in the communication center and SEGMENT 1. These labs would focus on developing more different ways of communication.

### METALLURGY LABS:

These labs would be used to study the metal samples obtained from the moon and asteroids. Research on metals will also be conducted here. These labs would be placed in the industrial area and SEGMENT 1.

### BIOTECHNOLOGY LABS:



Figure 57 . Research facilities

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These labs would focus on increasing the quantity and quality of agricultural commodities. They would also research on animals for better agricultural facilities. These labs will be located only in agricultural area.

## NANOTECHNOLOGY LABS:

Nanotechnology labs would focus on the development of nanotechnology in various fields such as medicine. These labs will be situated in the SEGMENT 1.

## CHEMICAL LABS:

Research on different chemicals and extraction techniques will be held here. Research on new materials will also be conducted here. These labs will be situated in SEGMENT 1 only.

## 7.5 INDUSTRIES.

Industries are places where processes such as extraction and manufacturing takes place. In INGRESS, various industries are located in the industrial torus. Manufacturing industries are where raw materials are transformed into different types of goods and new products would be produced. Extraction industries are the industries in which minerals obtained from the moon and asteroids would be extracted. Recycling industry is one of the most important industries, Recycling waste material and space debris would be processed here.

Various companies who would like to establish their industries in INGRESS will be provided with contracts .Industries such as textile and food will be very helpful to run our settlement. The industries will run with the help of robots and residents. Without industries, the settlement would be like a fish on a dry land. Therefore, we gave significance to industries and designed a special torus for the industries.



Figure 58 . Different kinds of industries

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The following table shows different industries in INGRESS.

Criteria	Purpose	Ground provision	Percentage
Mining industries	The extraction of asteroids will be performed here	102711.086	17
Recycling industries	Here the waste materials as well as debris would be recycled	114794.743	19
Textile industries	The textile industry is involved in design and production of clothing	18125.4857	3
Construction industries	Materials which are used for construction of banks, residential houses etc. will be manufactured here.	3029.1428	5
Recovery industries	The materials required for servicing and repairs will be manufactured here.	48334.6285	8
Transportation industries	The mechanisms required for transportation will be manufactured here.	42292.7999	7
Chemical industries	The production of industrial chemicals takes place here.	24167.3142	4
Food industries	The food materials such as milk, cheese, and chocolates will be packed here.	54376.457	9
Agricultural industries	The minerals, nutrients, fertilizers used for agriculture will be manufactured here.	24167.3142	4
Health care industries	Medical products would be manufactured here.	18125.4856	3
IT industries	Development of service and business will take place here.	18125.4857	3
Electronic industries	Electronic gadgets, lights, solar panels and other electronic devices will be manufactured here.	24167.3143	4
Transportation	Transportation in torus	12083.6572	2
Future expansions	-----	18125.4858	3
Others	-----	54376.4574	9
Total		604182857m <sup>2</sup>	100

# INGRESS

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## 7.6 RESIDENTIAL FACILITIES.

Shelter is one of the most important needs for humans. INGRESS would provide 4 types of residential facilities for the people in ingress. Different houses would be provided to the people according to the contract they will sign before settling in. The properties of the residential facilities are given below:

### (SINGLE FAMILY HOUSE) DUPLEX:



This is a 2 floor house which has the capacity to hold a single family. Duplex houses are moderately expensive. They have 8 to 10 rooms.

Figure 59 . Duplex House

### MANSION:



This is the house in which large families reside in. It is a large house with 3 floors & capacity of 30 people. These are constructed less in number due to their massiveness.

Figure 60 . Mansions in ingress

### CONDOMINIUM:



This is a large residential complex divided into individual houses holding a huge population of 48 families. There are 12 floors in which 4 individual units are constructed; there are totally 48 individual units in this condominium. Condominiums are less expensive.

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### BUNGALOW:



Bungalows are houses with 2 floors. They would hold two families, one family at the top floors and the other family at the bottom floor. There are six rooms in each floor.

Figure 62 . Bungalows in ingress

Types of buildings	No of buildings	No of people accommodated	No of floors	Percentage
Duplex	638	2552	2	20%
Mansion	42	1260	3	10%
Condominium	33	6336	12	50%
Bungalow	327	2612	2	20%
Total	1040	12760	19	100%

# INGRESS

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## 8. HUMAN SOCIETY

### 8.1 RECREATION.

*"The bow cannot always stay bent, nor can be human frailty subsist without some lawful recreation"*

- Miguel de Cervantes

Human life is more complicated than it looks. As every human being has to work in order to maintain their social status and to survive in this world, they will be exposed to a lot of stress. Over stress can be more dangerous than any disease a human can get. This is where recreation comes into action. In order to let go of the stress and give ourselves a chance to have fun, Recreation is required. Recreation plays a vital role in our life.

*"If bread is the first necessity of life, recreation in a close second"*

- Edward Bellamy

Our settlement also consists of many recreation centers in which various recreational activities can be performed.

#### RECREATION ACTIVITIES:

##### VIRTUAL REALITY GAMES:

By using the latest virtual reality technology, we can give the people a wonderful and amazing experience. Gaming such as forest adventure, mine craft etc., can be accessible through virtual reality technology and people can have an experience of visiting the places of earth etc.



Figure 63 . Virtual Reality world

##### GALACTIC-WRESTLING:

Zero gravity wrestling (or) Galactic wrestling is a special sport available only in the zero-gravity complex. Two players would have electric jets attached to their shoes, waist and elbows as well. The Main objective is to knock the opponent to the ground. People who like to play it "rough" can enjoy watching this sport. This can also be chosen as a career.

##### ZERO-GRAVITY SPORTS:

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Zero-gravity sports include zero gravity football (soccer), basketball, Dodge ball ex: players would have electric jets attached to their legs which would allow them to move in zero-gravity.

### ZERO-G HORROR CHAMBERS:



Figure 64 . Z-G Horror chamber

Horror.

### GALACTIC RACING:



Figure 65 . Galactic racing

### RECREATION IN RESIDENTIAL TORUS:

The activity is not as the name describes to be. The chamber is filled with space environment which is artificially created. People would be sent to have an experience as the last astronaut in space with the replica of the space suite. The person inside the chamber would experience events like being sucked by a black hole, entering into the asteroid belt, running out of oxygen, getting attacked by space debris chain reaction etc. This attracts tourists as well as residents as it gives an experience of thrill and

This sport is lot more than racing. It's a micro gravity bike racing on tracks having medaled roads. In addition to that, there is a piston which moves with a high velocity (less than the bike's velocity). If a player makes contact with the piston like structure, they are to be disqualified from the race. The race also works like an obstacle course. High speed bikes than use hydroxyl Terminated butadiene propulsion would be used in galactic racing.

# INGRESS

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Travelling to the Zero-gravity & micro-gravity complex does take a lot of time and money. Small recreation facilities are situated in residential torus which don't required much maintenance and supervision.

Shopping malls: Malls with theaters, sports, various foods, products etc.

Public parks: Regular public parks with little modification.

Clubs: Clubs were people meet and have fun.

Amusement parks: Parks with various rides, theaters, horror houses, special foods and other fun activates.

Gymnasiums: Gym's for men and women with equipment like treadmills, weights etc.

Restaurants, hotels & resorts: Restaurants are dining places for residents. Hotels & resorts are for staying and for tourists.

Football courts, basketball courts, tennis courts etc. will also be constructed.

## 8.2 DEMOGRAPHY

INGRESS would transport 12,760 people from earth to the settlement ranging between few months to 70 years. INGRESS would have equal number of male's population female population in order to balance the society. Larger number of unmarried people would be taken to improve their concentration on developing INGRESS. Citizens above 18 would be considered as adults, this is when they are able to make decisions such as employment, marriage etc. Citizens above 50 years would be consider as old people. INGRESS would have larger adult population because they would be necessary for managing the settlement

Population Distribution				
Age Group (inclusive)	Male	Female	Percentage	Total number
0-12 Children	497	497	7.5	958
13-18 Teenagers	638	638	10	1,276
19-40 Adults	3,190	3,190	50	6,380
41-50 Aged Adults	1,914	1,914	30	3,828

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51-70 Old aged individuals	159	159	2.5	318
Total	6,380	6,380	100	12,760

Employment sector Divisions		
Age Groups	Gender & Number	Profession
(0-12) Children (13-18) teens	Girls- 1,117 Boys- 1,117	Children's are our future. They will be provided with the best education and physical guidelines
(19-40) Active citizens(or) fully grown citizens	Male- 3,190	Professors, Philosophers, Doctors, Engineers, Scientist, Social workers, Government employees, Workers, Farmers, Astronauts
	Female- 3,190	Doctor, Nurses, Engineers, Scientists, Business women, Architects, Home makers, teachers, professors, Astronauts
(41-50) Semi-active Citizens	Male- 1,194	Counselors, Engineers, Businessmen, Scientists, Farmers, doctors, Workers.
	Female-1,194	Architects, homemakers, counselors, scientist, doctors, businesswomen, farmers.
(51-70) Aged citizens (old)	Male-159	They have a lot of life experiences. So, they will be the guide for the citizens. They will do the work of maintain a balanced society and a friendly community.
	Female-159	

## INGRESS

		They would lead the future generations towards peace and harmony.
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### 8.3 EDUCATION.

Today's children are tomorrow's citizens. Our future depends on the younger generation.

*"Children are not things to be moulded, but people to be unfolded"*

-jess lair.



Figure 66 . Creativeness in Education

INGRESS would provide matchless education to the young ones. Education is not an aspect to turn a blind eye on. INGRESS would have splendid teaching facilities that the world has never seen before. Children will gain knowledge and physical guidance. Every education facility would work directly under the government.

# **INGRESS**

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## **(KINDER GARDEN) PRE SCHOOL:**

Preschools provided education from ages 2 to 4 years. Children would learn some basic knowledge on how to speak, walk and run etc. Children in preschool would have a lot of fun in their schools by performing different activities.

## **(GRADE SCHOOL) PRIMARY EDUCATION:**

This is where the real basics in education start. Children from ages 5 to 12 years are considered in primary education. They would receive basic knowledge in every aspect; they will receive stress free education along with physical guidance. This is when teaching faculties will try to detect the children's creativity and notify their parents about their child's talents.

## **(HIGH SCHOOL) SECONDARY EDUCATION:**

This is when children grow into teenagers. This is education provided to the children during adolescence. Secondary education would be provided to children from ages 13 to 17 years. This is when children understand about their talent and decide their future goals. Therefore, physical fitness is really predominant in this stage. So, secondary education concentrates especially on the physical conditions of the children.

## **(UNIVERSITY) TERTIARY EDUCATION:**

Tertiary education is provided to people of 18 to 21 years. This involves choosing a main subject of their wish. After choosing a special subject such as astronomy, medical, computer science etc., students would be provided with brief explanations on that subject. Tertiary education provides 4 years of training on a specific subject. After this period, people would be eligible for jobs or they can do research on their specified subjects.

## **EDUCATIONAL FACILITIES:**

As INGRESS gives special significance to education, it would have marvelous teaching facilities. We would concentrate on children's creative knowledge rather than theories. INGRESS would provide facilities such as virtual labs, scientific labs etc., and exams are very rare in the world of INGRESS; they would be replaced by quizzes and oral tests. If a teacher or professor is not available at the school or college, they would be replaced with advanced teaching robots. If a student is absent for a period of time, tablet pc's would replace the students and the child can involve the class through video conference. Every class would be recorded and if a student needs more info about the class, they can access the footages any time they need. Children would also be provided with transportation. The teachers would be trained to concentrate on every child equally and show no partiality or discourage everyone. Children would also be taught briefly about the resources in INGRESS. Contests resembling NASA space settlement would also be conducted.

INGRESS would have four major educational facilities located in the residential torus. Each of these will have a school, high school and a university. Children would have a vacation each month; they would be taken to different parts of the settlement. This would help them to improve their knowledge and they

# INGRESS

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would have fun. The educational facilities in INGRESS would be equipped with advanced technology. During examination, students would be under camera surveillance. Silence is crucial during written test, so, everyone would have a sound detector under their desk or seat. This way everyone could write the exam fair and square. Cheating is totally forbidden in INGRESS, this helps the students to understand their capability and pursuit them to improve themselves.

## 8.4 GOVERNMENT.

*"Government is not reason; it is not eloquent; it is force. Like fire, it is a dangerous servant fearful master."*

-George Washington

### CONSTITUTION OF INGRESS:

- Equality before law
- Right against exploitation
- Cultural and educational right.
- Right on property
- Right on liberty
- Right to vote
- No one has right to pollute space

### POLITICAL STRUCTURE:

The government of INGRESS will be based on adult franchise (of age above 18 years).

### LEGISLATURE OF INGRESS:

INGRESS would appoint 25 cabinet ministers. The cabinet ministers have 6 years of tenure in council. If anyone has a crime record, they cannot be elected as a cabinet minister. For this post they should hold PhD. The people of age above 26 years can be elected as cabinet ministers. The elections will be free and fair. Different cabinet ministers will control different components of INGRESS. The president of INGRESS will watch the work of cabinet ministers and he runs the government. These cabinet ministers and president will be elected by residents of INGRESS. For electing cabinet ministers of lunar base we will be checking policies, votes and elect them as a cabinet member of lunar base. If any minister or president is known to take bribes, they will be imprisoned for 4 years. The tenure of president will be 6 years. For electing a president, we need them to be highly educated, they should also hold PhD. The minimum age to be elected as a president is 30 years. If any crime records are found, they will not be allowed to take part in the president election. Major part of segment 2 will be controlled by president of INGRESS.

DEPARTMENTS	NO. OF PEOPLE
Residential Torus	4
Agricultural Torus	3
Industrial Torus	2
Segment 1	1
Segment 3	1
Segment 4	1

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Communication center	1
Docking Port	2
Control Deck	1
Air Management	2
Transport	3
Waste Management	1
Recreation in residential torus	1
Lunar base	2
Total	25

## EXECUTIVE:

Police men and high post officers come under executive. These members will maintain peace in INGRESS. They will keep an eye on the president and legislature council as well. They will check all the money transactions done by the president and legislature. Totally this team of executive council consists of 6 members. All the 6 members would take care of different activities.

**HEAD OF THE COUNCIL:** He/she is the head of the council and he will check the work done by other members in the council, he/she acts as a commander to the executive council.

**SECURITY HEAD:** He keeps an eye on legislature council and president without them noticing. In other words, He/she is a secret agent.

**FINANCIAL HEAD:** The bills which are given by legislature will be checked by him/her. He/she calculates the budgets of system and calculates the cost.

**ADMINISTRATOR OF POLICE:** This person would check the work of police and command them.

**CHIEF SECURITY:** She will help the head of the council and ensure the security of INGRESS. She will secure the important files of INGRESS.

**ADMINISTRATOR OF SALARIES:** This person decides how much salary should be given to each employee.

We need highly educated people to process all these things for getting elected as a council member. People with age above 28 years can only participate in elections of the council members and the tenure for the member is 5 years.

## MONEY TRANSACTIONS:

Money transactions play a major role in our life. In our settlement we will be using electronic money transactions. These money transactions could be done by watches, phones, computers or laptops. But children would not be able to do money transactions. So, we would be using a transaction card of dimensions 76 mm X 49mm. This card will be connected to electronic gadgets so that money can be transferred into it.



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So, by using this method, parents can transfer artificial money to cards. Only people above 18 years are allowed to do electronic money transactions. But there is no age limit to use these cards.

## 9. ASTEROID MINING

Asteroids are known as minor planets in space. When the earth was at its initial stages, its gravity pulled all the heavy elements like gold, cobalt, platinum, tungsten to its core which we cannot access now. This left the crust of earth poor in elements which are necessary for the human life. After the earth cooled down, some asteroids which hit the earth gave us little amount of these elements. This proves that the asteroids actually contain a lot of elements which are very rare to find on earth. While days are passing, the need of these elements will increase. That is why INGRESS would use these asteroids to collect these minerals from them and utilize them. Research says that asteroids may have delivered most of earth's water to the planet when solar system was young. As water is very important and rare in space, asteroid mining would help us with the scarcity of water as well. Asteroid mining is very profitable because we can also sell the minerals obtained by mining which would earn us immense amounts of

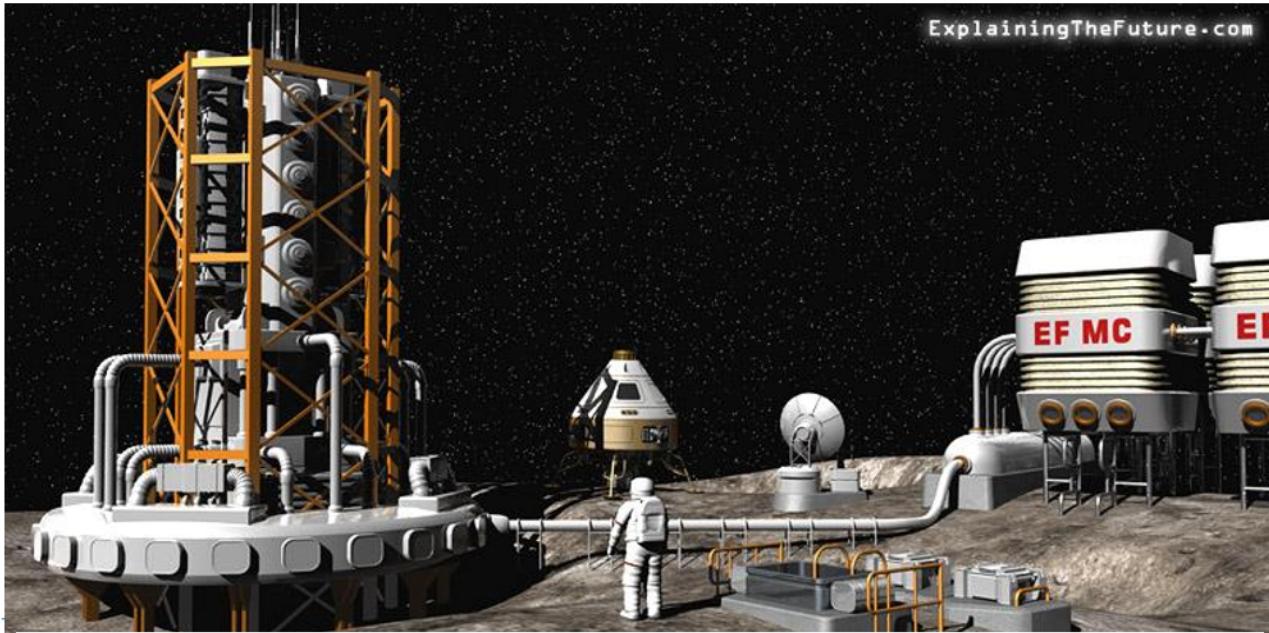


Figure 68 . Asteroid mining ( shaft )

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money. Another advantage from asteroids mining is that we can actually reduce the global catastrophic risks.

## 9.1 CHOOSING AN ASTEROID.

To mine an asteroid, we have to choose an asteroid first. There are infinite number of asteroid in the whole universe, the most accessible asteroids among them are the NEA's [near earth asteroids]. Until now, 15,342 NEA's are known. Selecting an asteroid from them is quite challenging. There are mainly three types of asteroids: C-type, M-type and S-type.

- 1] C-type asteroids carry a lot of water and organic carbon, phosphorus including other by ingredients for fertilizers which could be used to grow food.
- 2] S-type asteroids carry a little water and numerous metals such as nickel, cobalt, iron, gold, platinum and rhodium.
- 3] M-type asteroids contain up to 10 times more metal than S-type.

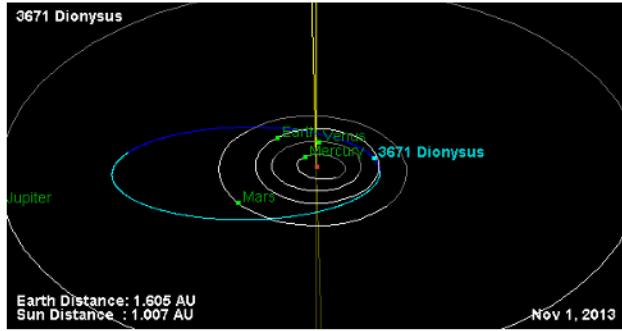


Figure 69 . Orbit of 3671 Dionysus

with a diameter of 1.5k. It is a C-type asteroid which means it carries a lot of water along with organic carbons. This asteroid would be helpful to INGRESS in a lot of ways .3671 Dionysus is considered as a potentially hazardous object. Because it's (MOID) minimum orbit intersection distance is less than 0.05 AU and its diameter is more than 0.15km. The other asteroid that we have chosen is an M-type Aten asteroid named 3554 Amun. It is the smallest M-type asteroid discovered and its economic value is approximately \$20 trillion. It is said to contain \$8 trillion worth of platinum, \$8 trillion worth of iron and nickel and a mere \$6 trillion worth of cobalt. Its estimated diameter is 2.48km. From these observations, we have chosen these two asteroids as our targets.

From these observations, we have confirmed that we require the help from C-type asteroids as water is more precious than gold in space. Thus, we mainly concentrate on catching C-type asteroids. INGRESS would also need the help of metals which would bring financial benefits for it. Based on some other observations, we have chosen two near earth asteroids to mine. One of them is 3671

Dionysus. 3671 Dionysus is a small Amor asteroid



Figure 70 . Orbit of 3554 Amun

## 9.2 Capture process

Capturing an asteroid is surely a major task. Capturing small asteroids [1m to 100m diameter] will be done very frequently as there are a very large number of potential targets. The mechanism used for capturing small asteroids should be retrievable and reusable. This mechanism would capture the

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asteroid and carry it to settlement. We have designed a stable mechanism which would be used to capture small asteroids and bring it to the settlement. Initially, the mechanism will approach the target and get disconnected as two parts. This would be done using the detachment ring below the octapress.

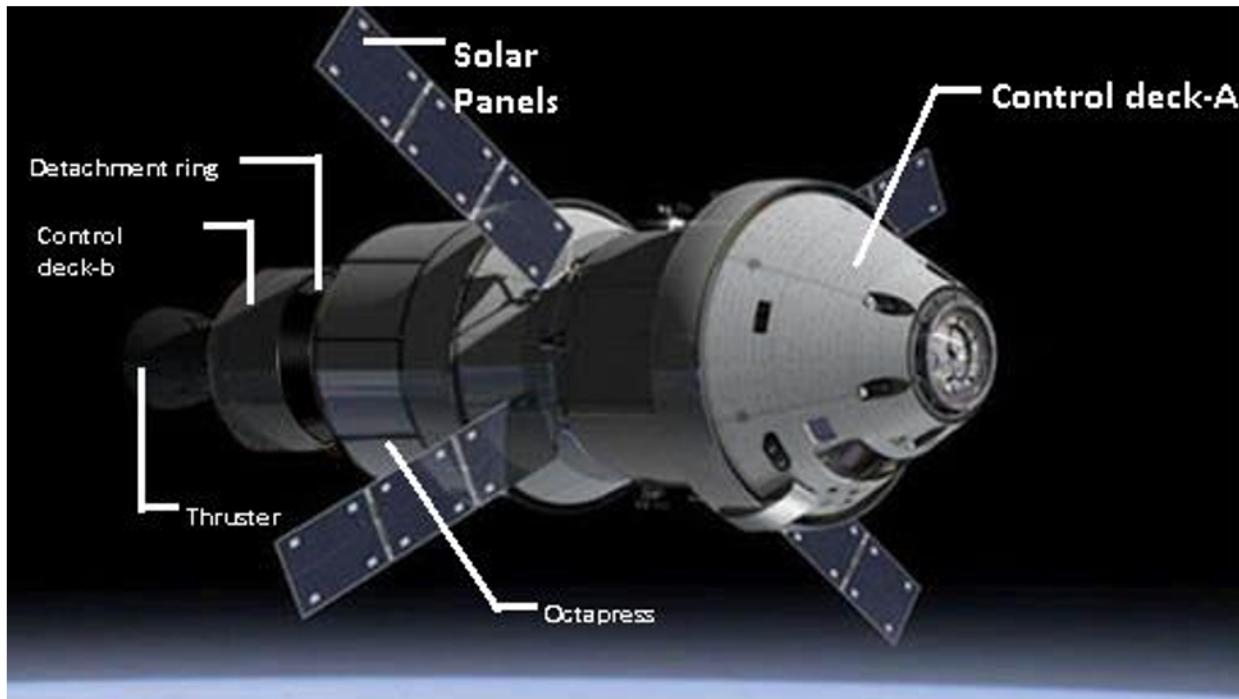


Figure 71 . Asteroid capture mechanism

After the detachment, the octapress would catch the asteroid by enclosing it from all sides which would make the asteroid stay fixed in a stable position. The ropes of the octapress are made out of superstring nano tubes to ensure a secure grip on the asteroids. Finally after the asteroid capture is complete, the sector which was detached would come back and get attached with the mechanism and it would bring the asteroid to the settlement. This is very secure and recommendable mechanism due to its cost and stability.

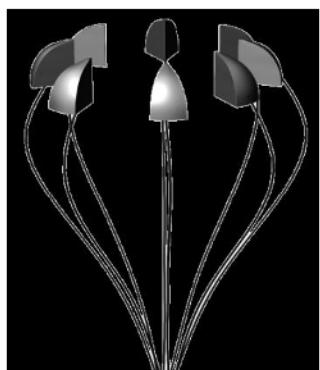


Figure 72 . Octapress capture mechanism

The large asteroids that INGRESS would capture will be 3671 Dionysus and 3554 AMUN. 3671 Dionysus will be the closest to earth on 8:19, jun-18-2085 at a distance of 0.0279973152719271 AU whereas 3554 AMNU will be closest to earth on 6:43, march-23-2061 at a distance of 0.2515377223611 AU. This will be the time when the capture process of these two asteroids will commence. To capture these asteroids, we need a different mechanism. Therefore, INGRESS will have another mechanism to capture the targets. The asteroid capture machine-B represents a dual belt.

It is equipped with quantum cascade lasers which would be helpful to break the asteroid. The inner and outer belts are made with titanium and other materials, these belts are joined with adjustable holders. The outer ring is equipped with thrusters. This mechanism is helpful to break the asteroid into several parts. Later, other capture mechanisms would capture these broken parts and deliver them to the settlement. The capture mechanism-B would be dismantled and recycled after serving its purpose.\

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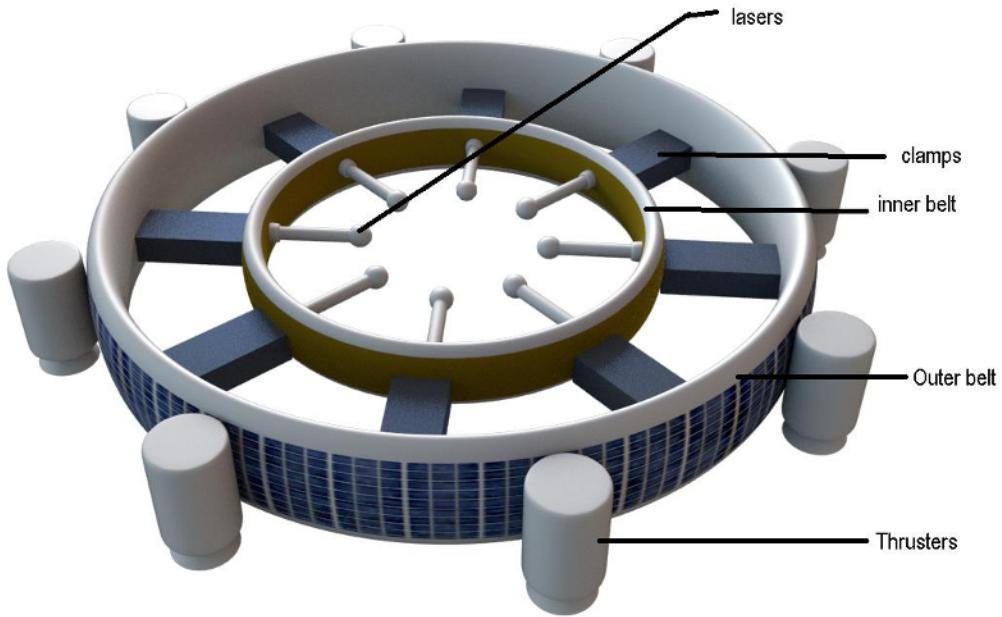


Figure 73 . Asteroid capture mechanism -2

## 9.3 Mining process

This is the final phase of asteroid mining. After the capture process of asteroid is completed, INGRESS would start extracting the minerals from the asteroid.

### EXTRACATION OF WATER:

Water is the most valuable material in space. Asteroids such as carbonaceous asteroids have high abundance of water and other volatile substances. These can be extracted by simply heating the asteroid. Heating the asteroid to  $510^{\circ}\text{C}$  would release hydroxyl, which would come out of the asteroid as substantial amount of water vapor. The vapor can be later condensed into liquid water. In this manner, water can be obtained from asteroids.

### SURFACE MINING:

There is strong evidence that many asteroids consist of rubble piles, those material would be scrapped off the surface using an auger. Surface mining provides us the knowledge about the materials available in the asteroid. For asteroid with a high metal content, magnetic rakes would be used to gather the lose metal grains covering the asteroid. Surface mining also includes removing useless particles such as rocks.

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## **EXTRACTION OF IRON AND NICKEL:**



Figure 74 . Nickel extracted from Mond process

Most of the metallic asteroids contain more than 50% iron and nickel in it. As they are very common in asteroids, we need a process to extract large amounts of iron and nickel. We have chosen mond process [also known as carbonyl process] to the extract these materials. Carbon monoxide combines with nickel readily and reversibly to give nickel carbonyl. This process involves passing carbon monoxide through the asteroid at a temperature of 50<sup>o</sup> to 60<sup>o</sup>. Finally the mixture of nickel carbonyl and syngas is heated to 220-250<sup>o</sup>c, this results in the decomposition of nickel carbonyl into nickel and carbon monoxide.



## **SHAFT MINING:**

After the extraction of important material such as water, iron, nickel etc. many other materials such as gold, platinum, copper, carbon will remain in the asteroid. To mine such material, a mine would be dug into asteroid and these materials would be extracted through the shaft. The desired ore would be transported to the industries where the extraction process is held.

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## 10. FINANCE

Finance is the study of investments and money management. INGRESS would need money before its construction is started. For collecting the money, a funding society will be created to collect money from different countries and the space organizations along with some private companies which would like to invest their money in INGRESS. The major investments which will be done for INGRESS will be on construction of the settlement, lunar base construction, asteroid mining and debris management the total cost of INGRESS is \$ 430 billion approximately. This is the amount invested along with some additional money.

### 10.1 Recovering the money back:

Earning money will be done in ingress in many ways, they are given below

- Contracts
- Industries
- Sale of extracted minerals
- Selling of concepts
- Tourism

#### CONTRACTS:

People who are willing to settle in INGRESS will have to sign different contracts. Houses will be given to those people according to the contract signed by them. They will be charged for taking a specific contract.

#### INDUSTRIES:

Industrial torus has different sectors where each of the sectors works on a different work. The commodities manufactured in the industries would also be sold to the people in INGRESS; some of the products such as recycled space debris would be sold in auctions for the people on earth.

#### SELLING OF CONCEPTS:

New technology concepts researched and used in INGRESS would be sold to different companies. These concepts include x-ray communication, space cube, asteroid capture machine etc

#### SALE OF EXTRACTED MINERALS:

INGRESS would collect a huge amount of minerals from the moon and asteroids. These minerals will be sold in auctions held on earth. Some of the minerals would be taken by INGRESS for its future use. The minerals extracted from moon and the asteroids will be sold from the year 2080. This sale is expected to fetch trillions of dollars.

#### TOURISM:

The microgravity complex, zero-gravity complex are major places in INGRESS in which tourists can enjoy very well. Tourism plays as an operation for recovering the money back as well. Tourists will be transported from the earth to INGRESS to view it. INGRESS would charge the tourists for this.

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## 10.1 COST:

STRUCTRUL COMPONENTS	COST
RESIDENTIAL TORUS	1,868,140,000\$
AGRICULTURE TORUS	923,117,000\$
INDUSTRIAL TORUS	901,751,966\$
SPOKE DESIGN A	57,5000,74\$
SPOKE DESIGN B	72,638,344\$
CENTRAL ROD	988,323,000\$
DOCKING PART	1,433,000,000\$
COMMUNICATION CENTRE	56,843,000\$
SEGMENT : 1	43,261,198\$
SEGMENT : 2	41,823,488\$
SEGMENT : 3	28,122,000\$
SEGMENT : 4	20,631,000\$
ILLUMINATION PRISM	16,984,182\$
HELIOS STATS	28,119,200\$
TILING	107,189,421,000\$
DOCKING STATION	6,034,680\$
<b>TOTAL</b>	<b>113,670,310,132\$</b>

INFRASTRUCTURE	COST
FLOORING	49,584,420,000\$
HYDROPONICS	998,946
AQUA PONICS	268,000
ZEO PONICS	162,000
ANIMAL HUSBANDRY	622,000
DUPLEX HOUSES	22,543,461
MANSIONS	5,69,168\$
BANGALOWS	8,09,143\$
CONDOMINIUMS	16,423,198\$
BANKS	526,000\$
COMMUNITY HALLS	430,000\$
HOLY PLACES	40,000\$
FIRE STATIONS	89,000
HOSPITALS & CLINICS	1,611,142\$
SCHOOLS AND COLLEGES	1,987,724\$
GRAVEYARD	64,000\$
STORAGE	2,709,042\$
OFFICES	3,002,941\$
STORES AND MALLS	939,000\$
<b>TOTAL</b>	<b>49,650,662,765\$</b>

Total facilities	Cost
Structural components	113,670,310,132\$
Infra structure	49,650,662,765\$
Life support	3,377,129,220\$
Lunar base	12,480,289,115\$
Asteroid mining	81,945,691,000\$
Debris	39,004,291,432\$
Others	130,000,000,000\$
<b>Total</b>	<b>430,128,353,664\$</b>

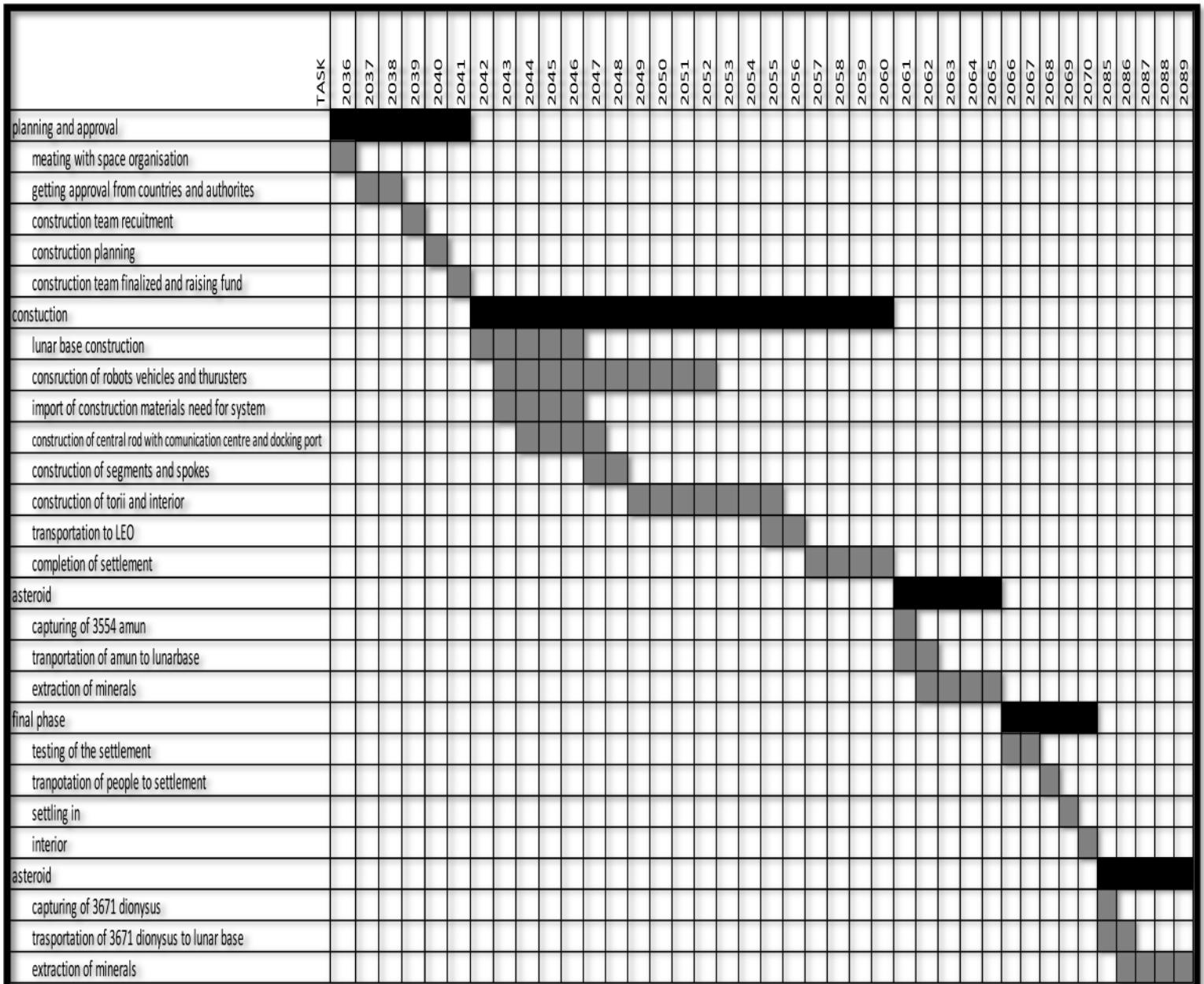
LIFE SUPPORT SYSTEM	COST
INDUSTRIES	1,002,463,931\$
HYPER WALL PYTHON	162,092,851\$
IOMP	55,621,984\$
ELEVATORS	18,954,612\$
SCIENTIFIC LABS	1,210,432,165\$
LIGHT	367,456,945\$
RECREATION	560,106,732\$
<b>TOTAL</b>	<b>3,377,129,220\$</b>

**TOTAL COST OF INGRESS:**

**430,128,353,662**

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## 11. SCHEDULE



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## 12. CONCLUSION

Our project's main goal was to create a new age. But it is not as simple as it sounds. We had to go through many situations to design INGRESS. The settlement would be situated in the LEO where we can take advantage of the earth to protect the colony from radiations. 12,760 humans would be transported from the earth to the settlement, but the structure is designed to hold more than 25,000 people without any major problems. The components of the settlement include 3 tori, 4 segments, a central rod along with a communication centre and a docking port. The tori are used for the project due to their ability to generate pseudo gravity if rotation takes place. The residential hybrid torus has a radius of 1185 m; this part will play the role of providing residence to the people. The agricultural truncated torus has a radius of 568 m; all agricultural functions will take place here. The Industrial hybrid torus has a radius of 572 m; various kinds of industries along with the most important recycling industry will be established here. As INGRESS would use x-ray communication due to its beneficial features, the communication centre would be constructed on the top of the settlement to protect the residents from x-rays. The ISCC would enable us to tackle the space debris problem and clean the space the space for a bright space future. Asteroid capture mechanisms have been introduced to capture asteroids and mine them. Recreation facilities will be provided to allow the residents to enjoy and get rid of their stress. All the money invested on the project would be easily earned using many methods such as tourism, contracts, Sale of concepts and minerals. Humans have gone through many ages and ended up in total confusions and wars, all of this took place on the earth, but the earth is just a tiny particle in the whole universe, and we have to leave our mother earth and discover new worlds and colonize them. We have introduced INGRESS with hopes to fly away from the earthly bonds into the space and transform it into our new home. This is not the end of anything, but it is just the beginning of a new era.

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## ABBREVIATIONS AND TERMINOLOGY:

ABBREVIATION	FULL FORM
LEO	Low Earth Orbit
RPM	Revolution per minute
G	Gravity
VACNT	Vertically aligned carbon nano tubes
IOMP	Ingress Omni mod pods
PhD	Doctor of philosophy
DNA	Deoxyribonucleic acid
X-rays	X-Radiations
I.T	Information technology
LED	Light Emitting Diode
NEA	Near Earth Asteroid
PC	Personal Computer
MOID	Minimum Orbit Intersection Distance
AU	Astronomical Units
ESA	European Space Agency
ISS	International Space Station
MDB	Mesh Double Bumper
EPFL	École Polytechnique Fédérale de Lausanne
EDDE	Electrodynamic Debris Eliminator
NASA	National Aeronautics and Space Administration
JAXA	Japan Aerospace Exploration Agency
ISCC	Ingress Space Cleaner Cube

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