

Education, Research and Technology Incubation for Nation Building

PRESENTATION IN
Faculty Meet, NIT Kurukshetra

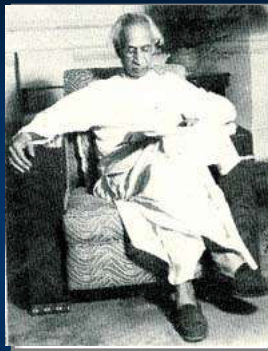
BY

Dr. A. SIVATHANU PILLAI

Distinguished Scientist & Chief Controller (R&D) DRDO
Chief Executive & Managing Director, BrahMos Aerospace

27 December 2013

Influence of education in nation building



Dr. S. Radhakrishnan
Former President of India

A philosopher-statesman, a
scholar and an innovative
educationist

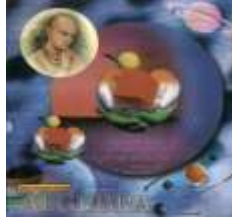
“We cannot make or build
the Nation by just bricks and
mortar.

We have to establish **the
minds of young people**, who
alone can transform the
Nation.”

A GLIMPSE OF GREAT SCIENTISTS OF ANCIENT INDIA



ARYABHATT (476 AD)
ASTRONOMER & MATHEMATICIAN
 First to proclaim that the earth is round & rotates on its axis
 Calculation of π (Pi) to 3.1416 and sine table in trigonometry.



BHASKARACHARYA II (1114-1183 AD)
GENIUS IN ALGEBRA
 First to discover gravity, 500 years before Sir Isaac Newton.



ACHARYA KANAD (600 BC)
FOUNDER OF ATOMIC THEORY
 Said "Every object of creation is made of atoms which in turn connect with each other to form molecules".



ACHARYA SUSHRUT (600 BC)
FATHER OF PLASTIC SURGERY
 Performed Rhinoplasty (restoration of a damaged nose); prescribed treatment for 12 types of fractures & 6 types of dislocations.

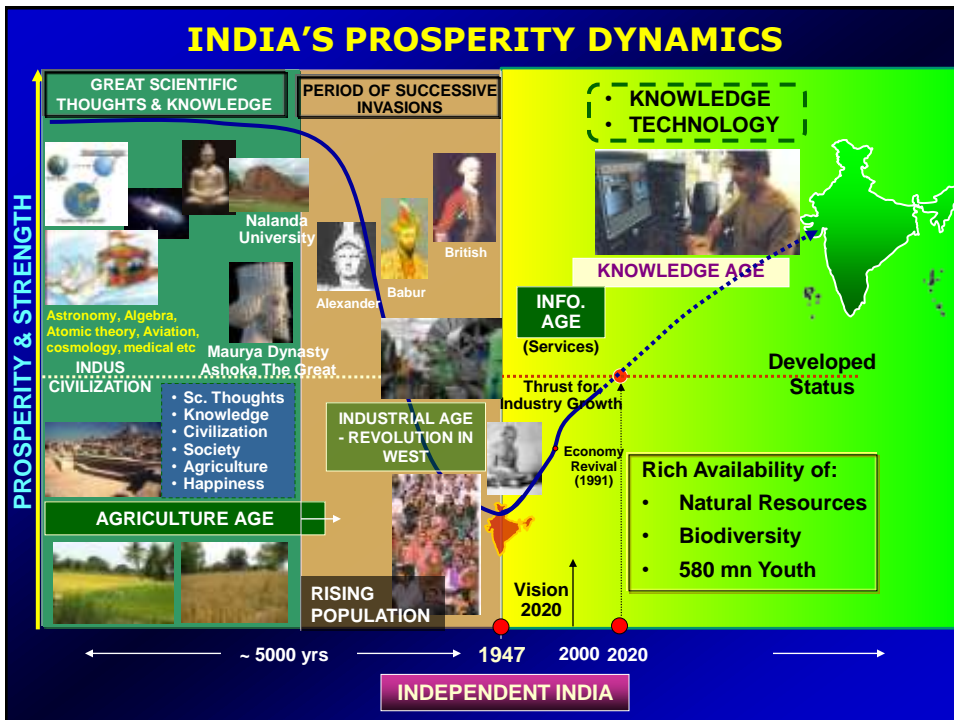


ACHARYA BHARADWAJ (800 BC)
PIONEER OF AVIATION TECH.
 Designed and described about the techniques in aviation technology



ACHARYA KAPIL (3000 BC)
FATHER OF COSMOLOGY
 Given concept of transformation of energy

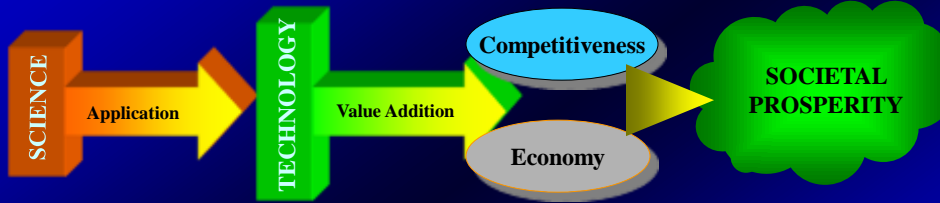
Source: Indian Institute of Scientific Heritage, Trivandrum, www.iish.com



TECHNOLOGY : THE GAME CHANGER

Technology is a NON-LINEAR Tool

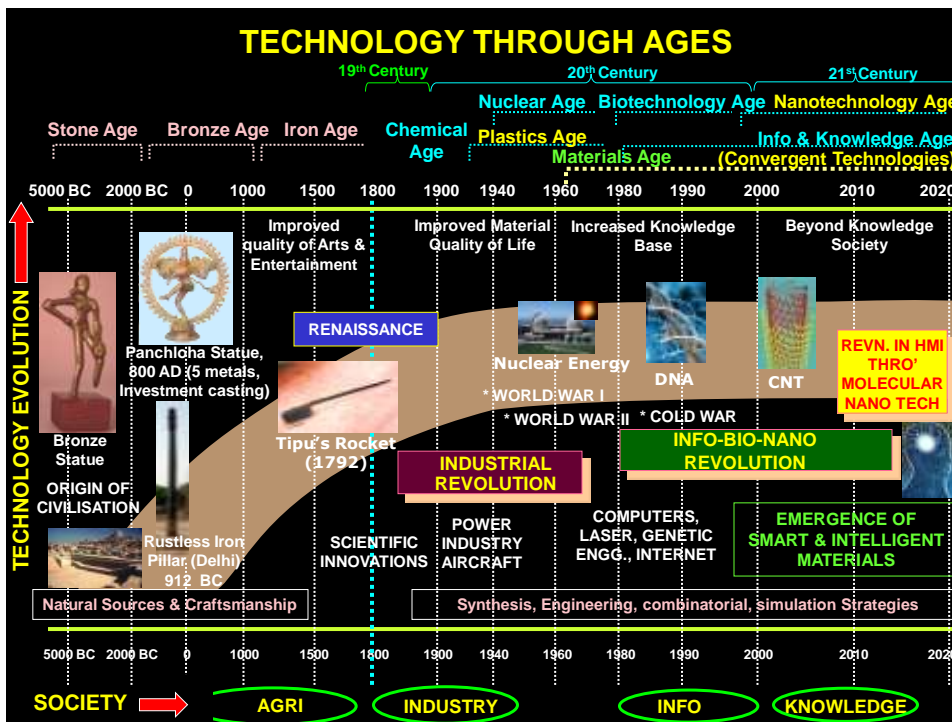
Technology can effect the most fundamental changes in the ground rules of economic competitiveness



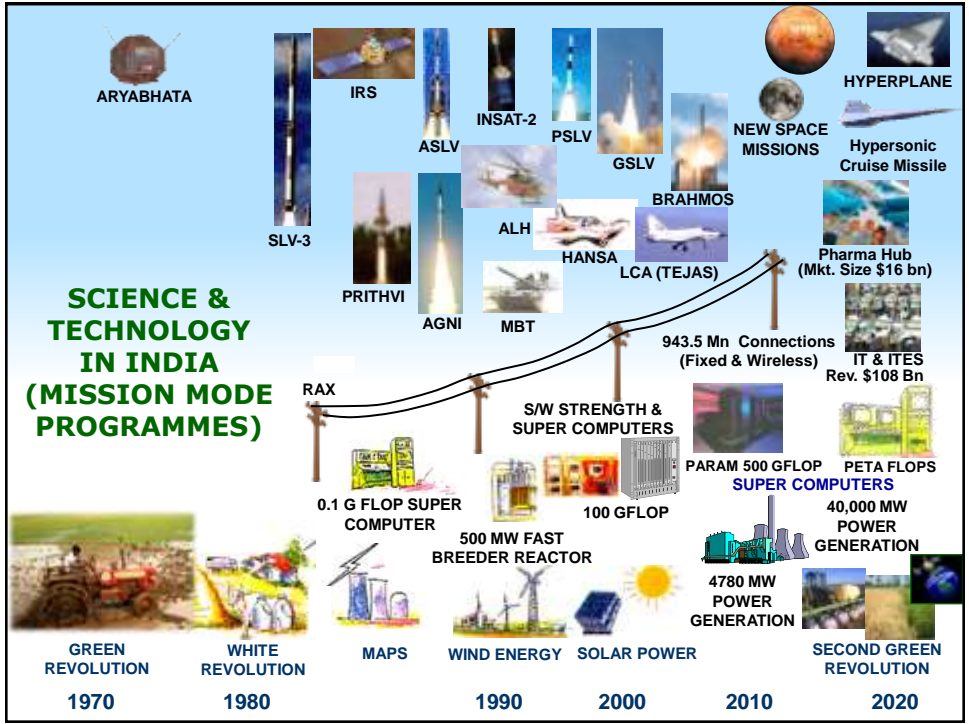
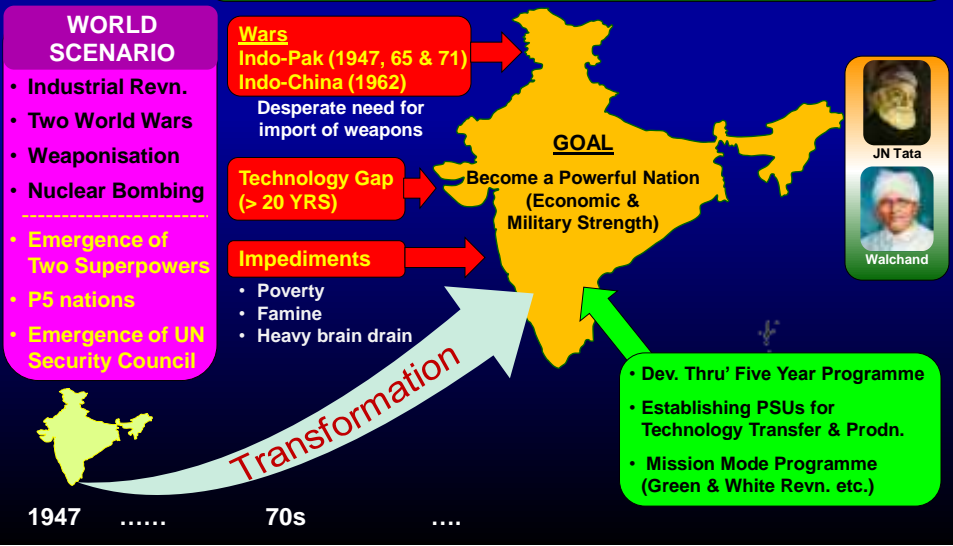
Science is linked to Technology through Applications

Technology is linked to Competitiveness & Economy through Value Addition

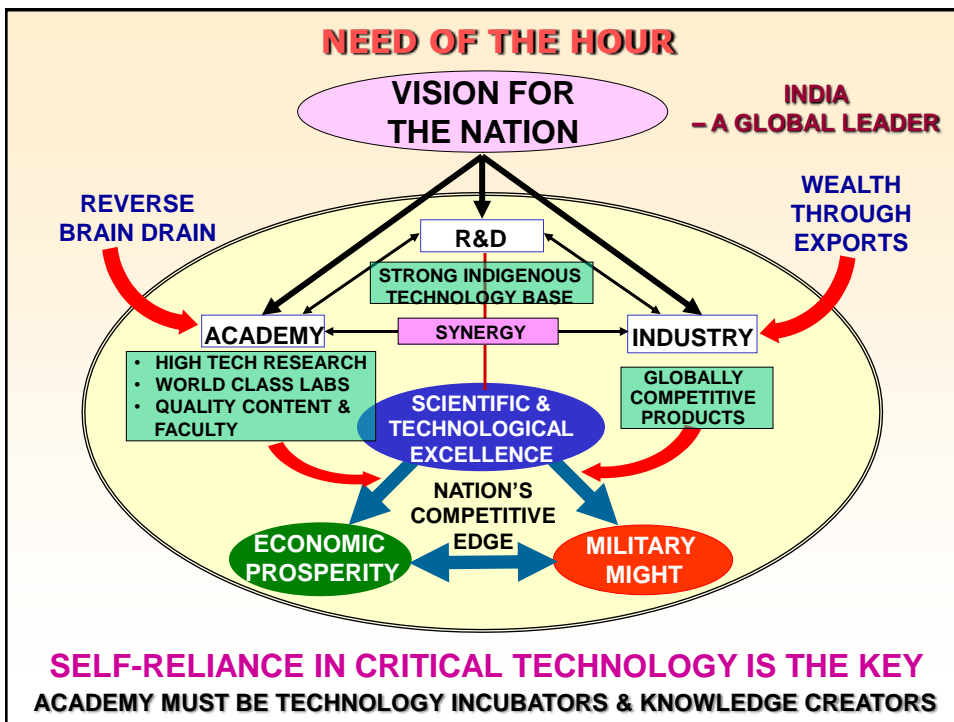
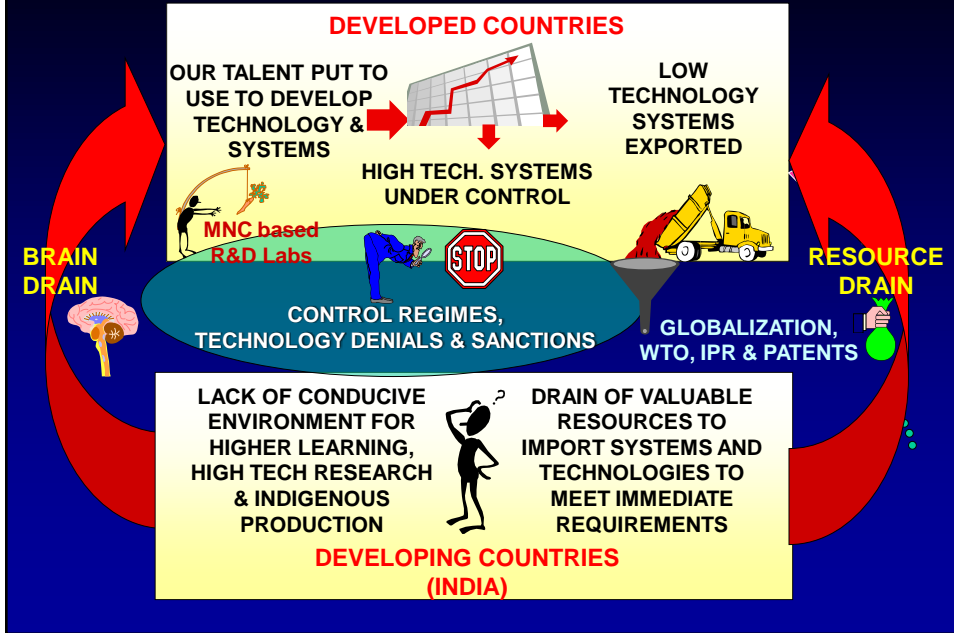
Economy and Competitiveness lead to Societal prosperity



TECHNOLOGY POWER THRU' VISIONARIES



HURDLES IN THE PATH OF DEVELOPMENT



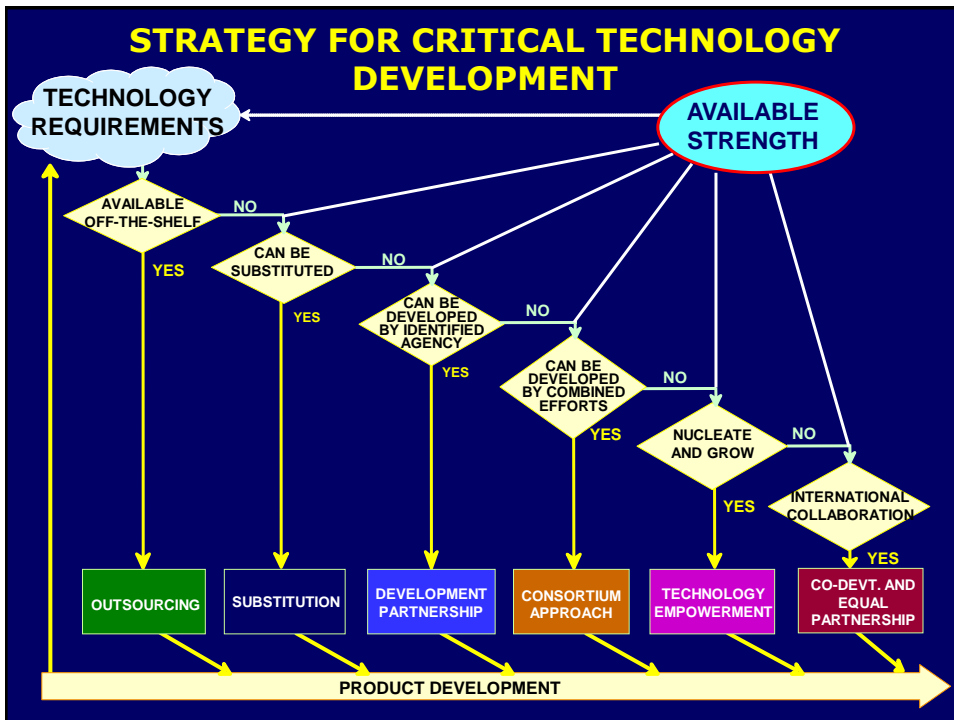
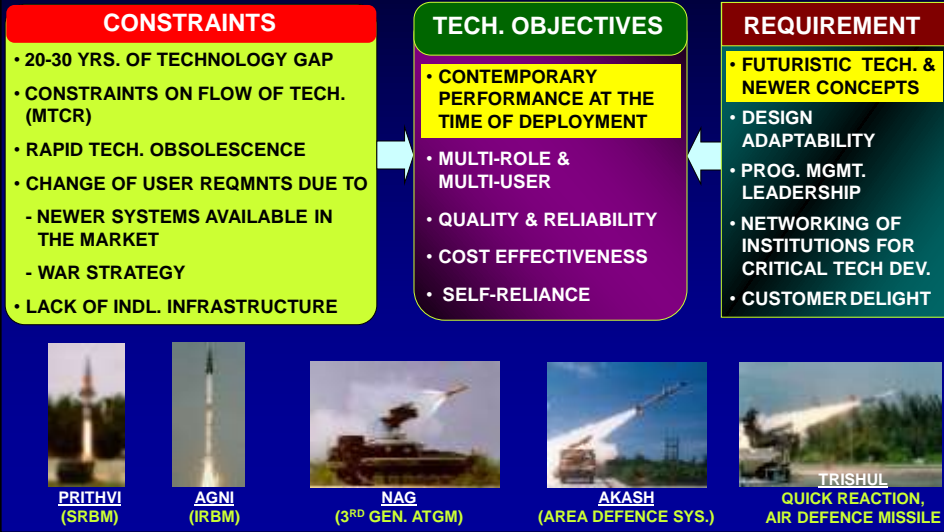


Dr. APJ Abdul Kalam

INTEGRATED GUIDED MISSILE DEV. PROG.


(JULY 1983)

Realisation of Indigenous Technologies under Control Regime (MTCR)




PRITHVI


INNOVATIVE CONCEPT OF MANOEUVERABLE TRAJECTORY



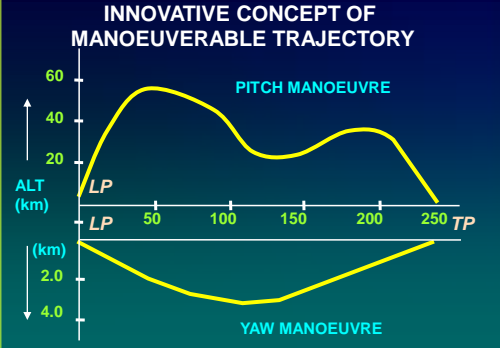
P-I




P-II





P-III




MULTIPLE WARHEADS


PREFRAG


BOMB LET


INCENDIARY


BCES

FEATURES

- * MANOEUVERABLE TRAJECTORY
- * HIGH ACCURACY
- * MULTIPLE, FIELD INTERCHANGEABLE, WARHEADS WITH HIGH LETHALITY

	P-I	P-II	P-III (DHANUSH)
RANGE (KM)	150	250 / 350	350
USER	ARMY	AIRFORCE, ARMY	NAVY


ACADEMIA PARTICIPATION - CASE STUDIES

PRITHVI GUIDANCE & CONTROL SYSTEM

High Accuracy from medium grade sensors

Dynamically Tuned Gyro (DTG)


- Bias Stability : 0.3
- Scale Factor Stability: 100 PPM




Coarse Sensor Pulses

Force Feedback Accelerometer


- Bias Stability : 150µg
- Scale Factor Stability : 100 PPM



IMU




OBC



Sensors Packed in Thermal Chamber

STATE-OF-THE-ART TECHNOLOGY CAPABILITY

FLIGHT EVALUATION



ENGINEERING, PROTOTYPE FABN. & TESTING

HILS

INS + OBC

5 AXIS SIMULATOR

COARSE SENSOR

↓

Calibration & Error modeling

↓

IMPROVED SENSOR ACCURACY

NAVIGATION ALGORITHM

↓

S/w for Drift compensation

↓

JU

HYBRID SIMULATION

↓

GUIDANCE ALGORITHM

EMBEDDED SOFTWARE (Navigation & Guidance)

↓

SUBSTITUTION

AGNI PROGRAMME

Agni II

L (m)	20
Dia (m)	1
Launch Wt (T) (Incl. Payload)	16
Range (km)	2000

AGNI-V

Agni III Agni V

AGNI	III	V
L (m)	16.7	17.5
Dia (m)	2	2
Launch Wt (T) (Incl. Payload)	48.3	50
Range (km)	3500	5000

Agni I

L (m)	15
Dia (m)	1
Launch Wt (T) (Incl. Payload)	12
Range (km)	700

Agni IV

L (m)	20
Dia (m)	1
Launch Wt (T) (Incl. Payload)	17
Range (km)	3000

RE-ENTRY DESIGN

SUPER COMPUTER FOR COMPUTATIONAL FLUID DYNAMICS (CFD)

NEED FOR CFD

- HYPERSONIC FLOW INVOLVING NON-EQUILIBRIUM CHEMISTRY NOT AMENABLE TO CONVENTIONAL METHODS
- EXPERIMENTATION REQUIRES LARGE SIZE HYPERSONIC WIND TUNNEL FACILITY
- NON AVAILABILITY

REQUIREMENT

- SUPER COMPUTER
- FAST CFD CODES

100,000 Grid Points

TECHNOLOGY CAPABILITY FOR SUPER COMPUTER & ADV. CFD S/W

CODES

(EULER, BHEEMA, VEEMA, KAREESHMA, Navier Stroke Solution)

PARALLEL PROCESSING
(8 / 32 / 128 NODES)

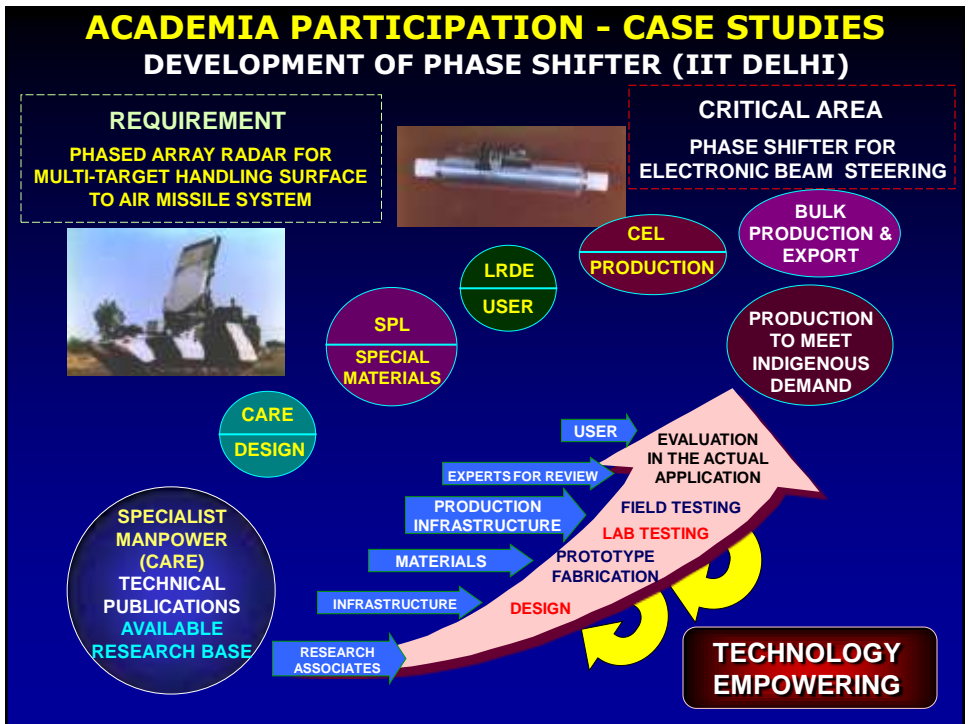
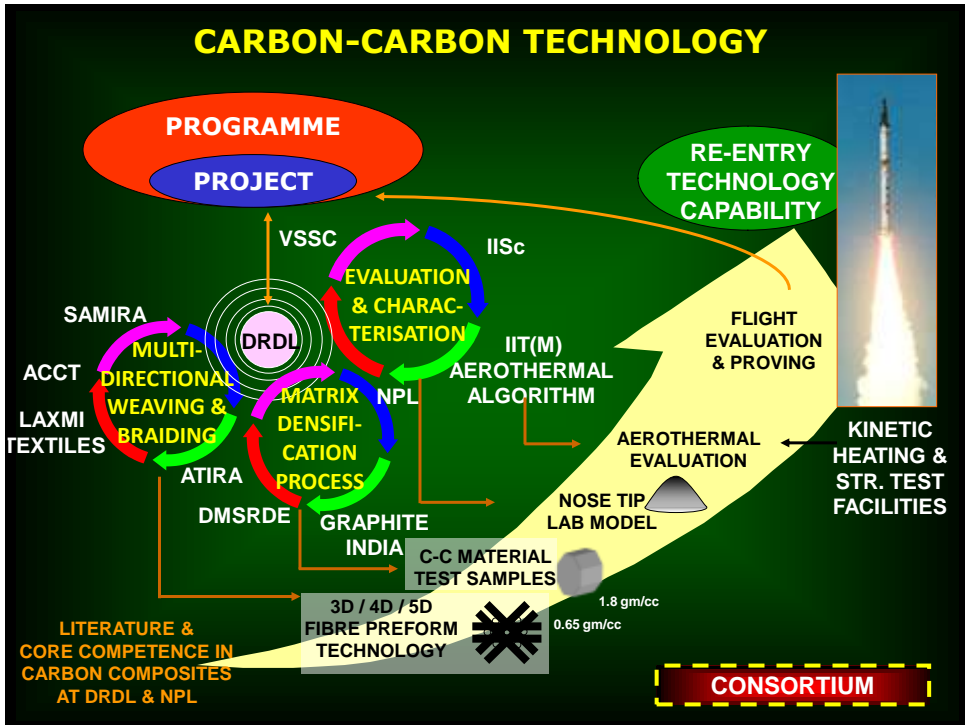
Conventional Main Frame Computers
(9 days/iteration)

PACE* WITH 1.7 G.FLOP IS
20 TIMES FASTER THAN CRAY-XMP

CFD CENTRE (IISc) + COMPUTING LAB (ANURAG)

(5 min. / iteration)

CHALLENGE



REALISATION OF CRITICAL TECHNOLOGIES TO COMBAT MTCR

RE-ENTRY / CFD RL GYRO GUIDANCE & CONTROL SEEKER IMAGE PROCESSING

SUPER COMPUTER ANUSIG ANUPAMA PROCESSOR SAGAR VIRTUAL REALITY

COMPONENTS & DEVICES GATEC SITAR RAJENDRA 3D CAR

PROPULSION FLOATING POINT DSP HYDROPHONE SONAR CERAMIC RADOME MATERIALS / COMPOSITES

TECHNOLOGY DENIED IS TECHNOLOGY GAINED

MISSILE POWER

LONG RANGE BALLISTIC MISSILES

700 TO 5000 KM

CRUISE MISSILE (STRIKE WEAPON)

BRAHMOS

LAND TO LAND
LAND TO SEA
SEA TO SEA
SEA TO LAND
UNDER WATER
AIR TO GROUND

AIR DEFENCE

AKASH

BALLISTIC MISSILE DEFENCE

AAD

PAD

TACTICAL MISSILES

ASTRA

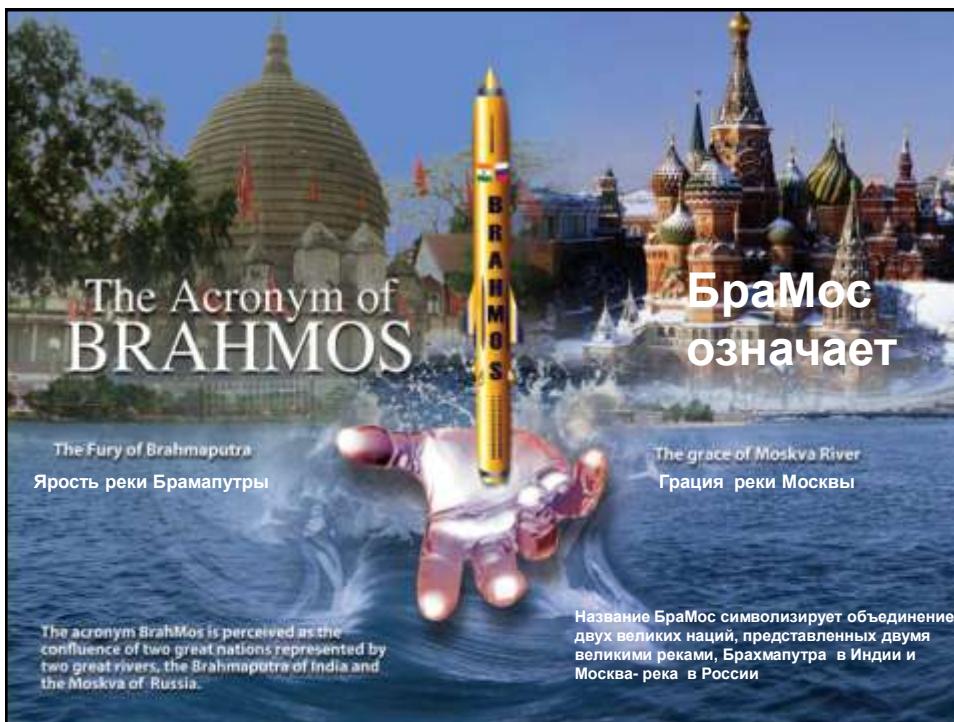
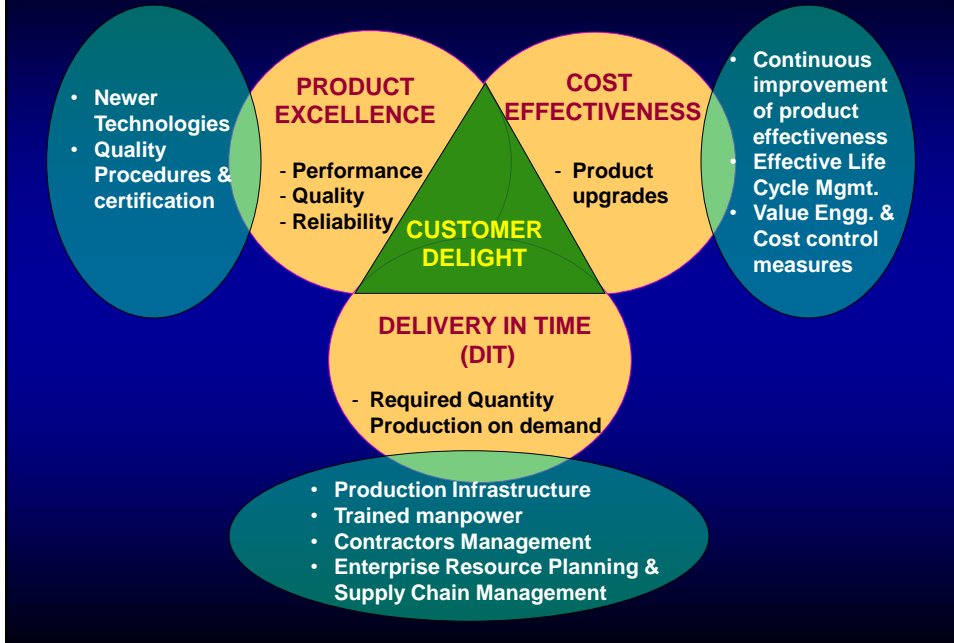
NIRKHAT

PRITHVI

SHORT RANGE BALLISTIC MISSILES

300 TO 700 KM

GLOBAL COMPETITIVENESS OF PRODUCT





BRAHMOS FOR NAVY



290 KM

PRECISION HIT OF TARGETS



WITH WARHEAD

MISSILE SYSTEM IN SERVICE WITH INDIAN NAVY

SHIP TO SHIP, SHIP TO LAND & LAND TO SHIP VERSION READY



Without warhead


BRAHMOS LAUNCHES

AGAINST LAND TARGET




UNDERWATER LAUNCH



BRAHMOS LAND ATTACK CAPABILITY





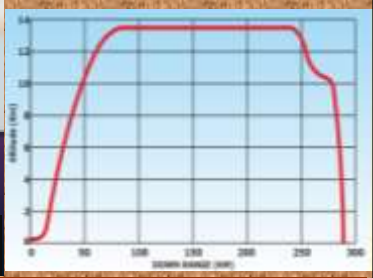


PRECISION HIT ON LAND TARGETS

2 REGIMENTS INDUCTED IN ARMY

CONTINUOUS CAPABILITY ENHANCEMENT (Creating Dynamic Environment and Excitement)

<p>BRAHMOS BLOCK-I</p> <p>Precision strike on high value single target</p>  <p>Applications: Sea to Sea ASM Land to Sea Land to Land Desert Warfare</p>	<p>BRAHMOS BLOCK-II</p> <p>Land Target with Discrimination and Surgical Strike Capability</p>  <p>Applications: Land to Land Desert Warfare and Urban Warfare</p>	<p>BRAHMOS BLOCK-III</p> <p>High Manoeuvrability and Supersonic Steep Dive</p>  <p>Applications: Land to Land Mountain Warfare Surgical Strike Capability</p>	<p>Steep Dive Capability</p>  
--	--	--	---

UNIVERSALITY WITH S/W & H/W ADAPTABILITY FOR SEA AND LAND TARGETS

DEPLOYMENT OF BRAHMOS ON SU-30



Air Launched BRAHMOS

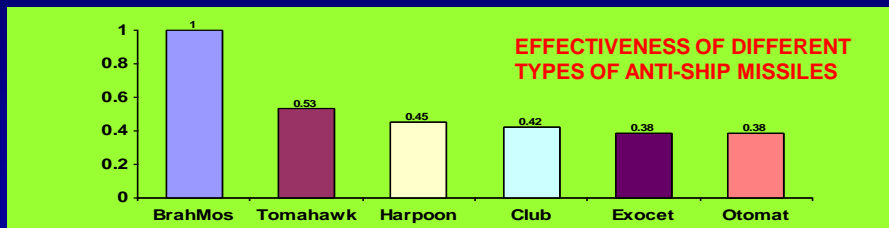


BASIC SPECIFICATIONS

Number of missiles per Aircraft	- 1
Range	- up to 290 Km
Velocity	- up to 2.8 Mach
Altitude	- cruise phase - up to 14000 m - terminal phase - 5-15 m
Take off mass	- 2500 Kg
Length	- 8500 mm

TOMAHAWK Vs. BRAHMOS

	TOMAHAWK	BRAHMOS
Speed	0.8 Mach	2.8 Mach
Time to hit the target	1 unit	1/3 rd (Faster engagement)
Kinetic Energy	1 unit	9 times. (High Destructive Power)
Target Dispersion (Moving targets)	1 unit	1/3 rd (Probability of hit is high)
Reaction Time	1 unit	1/3 rd (Pierces the Defence)
Universality	Nil	Same system for sea & land targets
Salvo	3 sec	2.5 - 3 Second interval on multiple targets (Land and Sea)



BRAHMOS – WORLD LEADER IN CRUISE MISSILE FAMILY

INDIA - RUSSIA JV BrahMos – A ROLE MODEL



Scope:
Dev. of ASM from
Mobile Complex

- Realised:**
- Land to Ship
 - Ship to Ship
 - Land to Land
 - Ship to Land
 - U/w to Ship



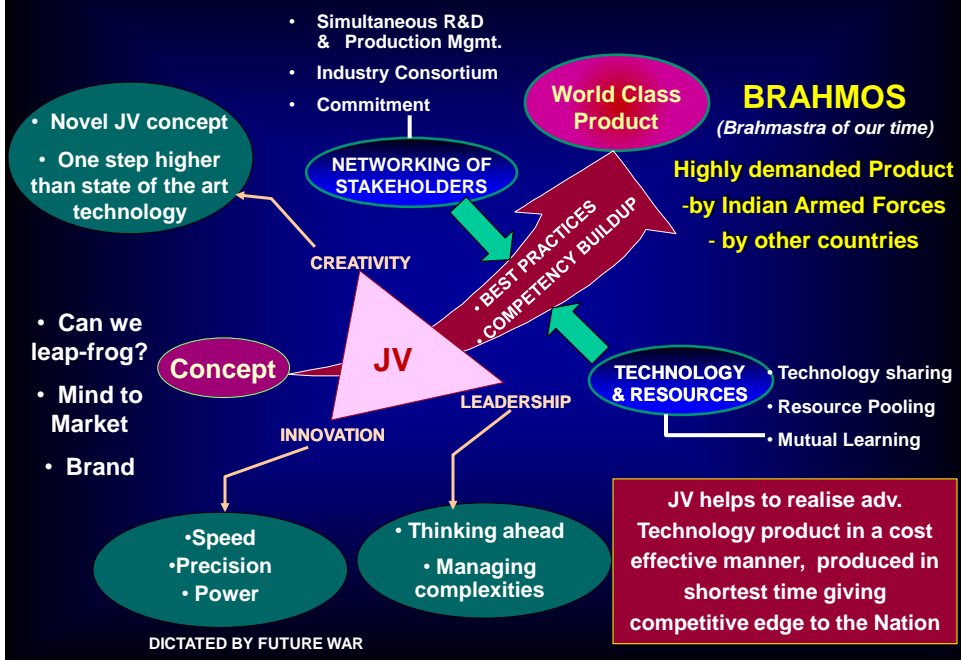
- Naval & Army versions successfully completed within time. Produced, Delivered & Operational
- Indian Army is the only Land Force in the world to have Supersonic Precision Strike Cruise Missile
- Universality for multi platform, multi target and multi mission achieved.

Investment:
\$ 300 mn

BUSINESS →

Present Order :
~ \$5 bn

GLOBALLY COMPETITIVE PRODUCT



**VENTURING INTO THE
HYPERSONIC WORLD**
...where Speed is the POWER!
There is nothing like a dream to create the future.

SUDHARSHAN CHAKRA

CENTRES OF EXCELLENCE IN HYPERSONICS

*Signing of MOU with IISc on
12th June 2011 at New Delhi*

**INDIA'S
Pride
in
PROGRESS**

**VENTURING INTO THE
HYPERSONIC
WORLD**
Where
**SPEED is the
POWER**

Inauguration of the Centre of Excellence 08 Nov 2011

FUTURISTIC THRUST AREAS FOR RESEARCH

- ROBOTICS & AUTONOMOUS SYSTEMS
- SPACE BASED INTELLIGENCE, SURVEILLANCE & RECONNAISSANCE
- KINETIC ENERGY WEAPONS
- PRECISION DELIVERY SYSTEMS – SUPERSONIC & HYPERSONIC MISSILES
- STEALTH SYSTEMS – INVISIBILITY
- SMART MATERIALS
- NANO DEVICES / SENSORS
- PHOTONICS
- CYBER SECURITY

ROBOTS

Unmanned Air Vehicle (UAV)



MICRO UAV



Remotely Operated Vehicle



Legged and Wheeled Robot



Humanoid Soldier



Battle Tank




Unmanned Ground Vehicle




Unmanned Sea Vehicle

SPACE BASED EARTH OBSERVATION SATELLITE

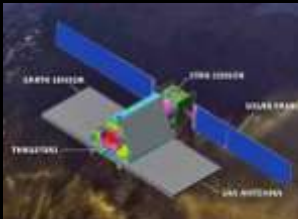
AIR BORNE ISR




AWACS




AEROSTATS




Radar Image Satellite RISAT




OCEANSAT



**IMS
Military Surveillance
Satellite**



CARTOSAT



**Space Based Infra-Red
System Architecture
for missile defence**

KINETIC ENERGY WEAPONS

High Power Lasers



TYPICAL OPERATIONAL SCENARIO



LASER BEAM DIRECTOR



MOBILE PLATFORM



**SPACE BASED LASER AGAINST
BALLISTIC MISSILES**

High Power Microwave

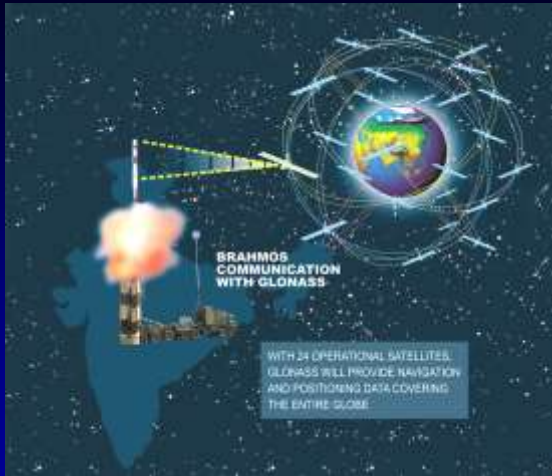


EMP explosion schematic




AIRBORNE TACTICAL LASER

PRECISION DELIVERY SYSTEM



Precision - GLONASS with P-code (2 m)



*Precision Strike
Land Attack Cruise Missile*



Hypersonic Reusable Missiles

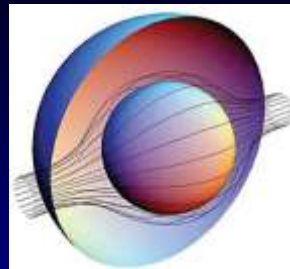
STEALTH SYSTEMS – INVISIBILITY



Stealth Bomber



Invisible Tank



Meta-Metals

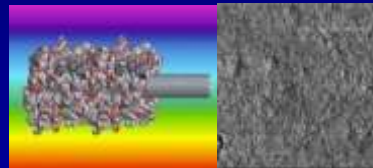


**STEALTH SHIP
SMART RADAR**




Stealth

- Radar absorption
- Thermal suppression
- Adaptive camouflage smart skin




CNT + Matrix Structure


SMART MATERIALS




Piezoelectric




Conducting Polymers




Thermochromic



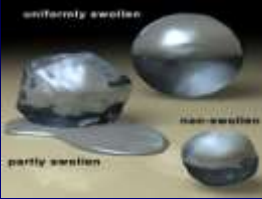
Shape Memory Materials




Dielectric Elastomers



Photochromic



Polymer Gel



Electroluminescent

NANO APPLICATIONS FOR DEFENCE



Flexible radar antenna



NanoSar SAR



Phased array radar



Micro UAV



Wireless Soldier



Smart Vest (DEBEL)



Brain Implant Chip



Brain Computer Interface



Smart Helmet



Nano Air Vehicle



Nanomaterial for Surface protection



Nano Energetics



Microfibre nanogenerator for energy storing



Wearable power with nanomembrane fuel cell

NANO AIR VEHICLE



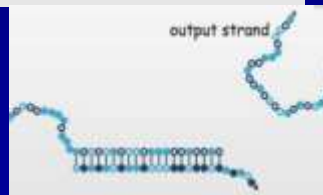
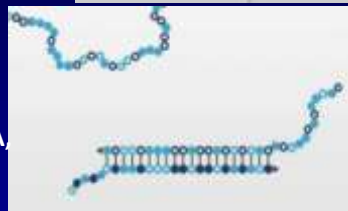
Artificial hummingbird weighs less than an AA battery

Source: DARPA

- ❖ Wingspan : 16 cm; Weight: 19 gms
- ❖ Contains batteries, motors, & communications systems; as well as the video camera payload
- ❖ Can fly at 17 km/h and move in three axes of motion
- ❖ Can climb and descend vertically; fly sideways left and right; forward and backward; rotate clockwise and anti-clockwise; and hover in mid-air
- ❖ Manoeuvres using its flapping wings for propulsion and attitude control
- ❖ Could be deployed to perform reconnaissance and surveillance in urban environments or on battlefields

FIRST ARTIFICIAL NEURAL NETWORK OUT OF DNA

- Major step toward creating artificial intelligence in a test tube
- DNA based neural network consists of 4 neurons made from 112 distinct DNA stands
- This network proved to figure out the incomplete pattern as to what it might represent
- Artificial neural network made out of DNA, creating a circuit of interacting molecules can recall memories based on incomplete patterns, just as a brain can



DUPLICATING HUMAN BRAIN IS NOT FAR

THIS IS NANO REVOLUTION

Source: Caltec, July 2011

THE FUTURE

Nanotechnology is creating smart materials that will replace & improve every part of body. Powerful new senses & abilities will create a super human

BRAIN – Implanted sensors that convey where you are, where you're moving and how to find your friends in a crowd

ARTIFICIAL VISION that allows us to see in infrared, ultraviolet and x-ray

DNA HAND SHAKE – sensor to check a person's identity from their DNA

UNBREAKABLE BONES – strengthened with CNT or artificial mother-of pearl

MUSCLES fatigue-resistant stronger muscles with smart materials

NANONURSES small robotic devices move above the body detecting chemical signals of damage & dispensing appropriate doses of drugs or cells to repair tissue

NEW ORGANS grown on biodegradable scaffolds that last longer and perform better than the original

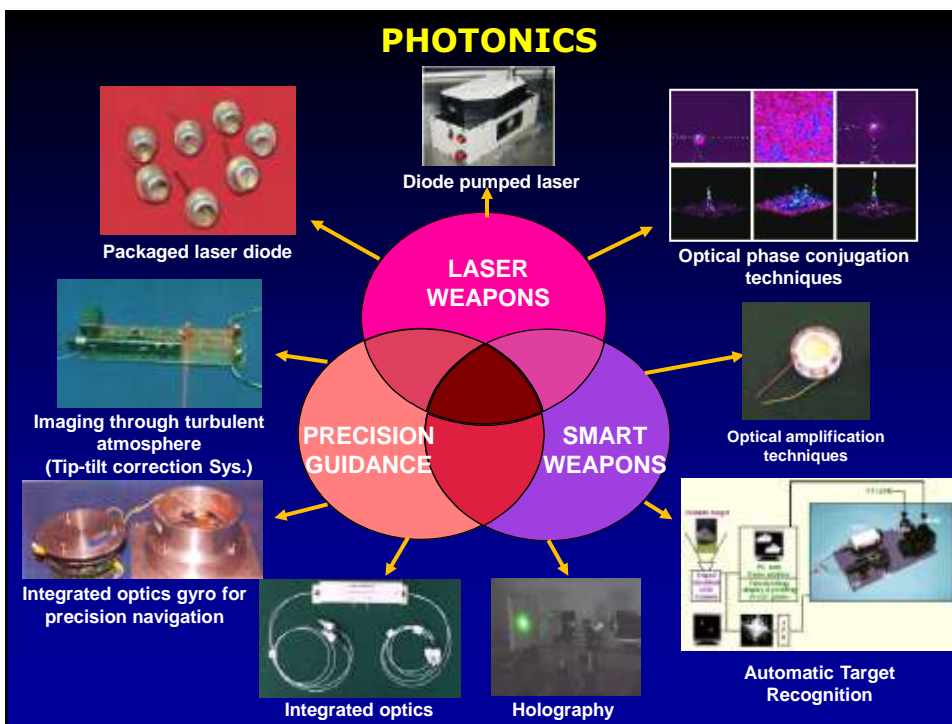
BODY WASTE Automatically analysed for signs of illness

EARS that hear across a wider range of frequencies.

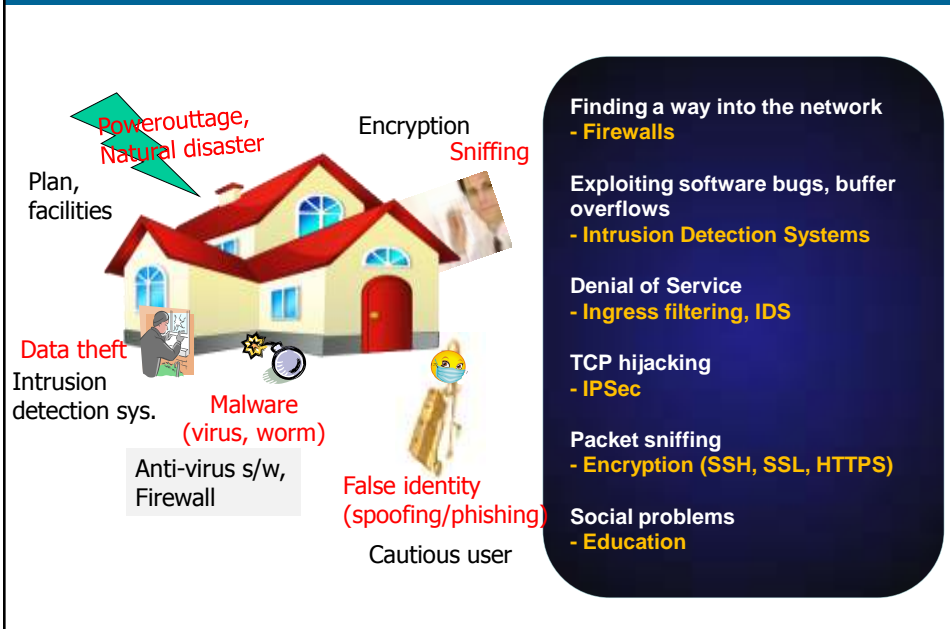
TRANSLATION Tiny molecule-sized computers able to translate conversations

FLAWLESS SKIN from combination of cells & synthetic polymers

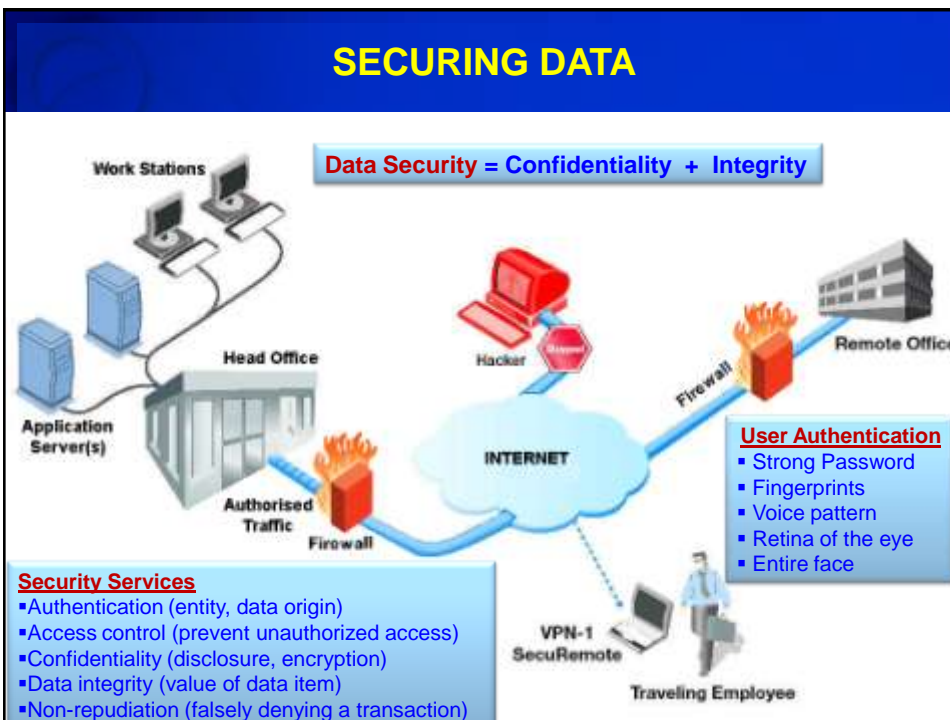
Source: <http://www.smh.com.au>
Illustration: Jojin Kang



CYBER SECURITY EXTERNAL THREATS



SECURING DATA



GREEN TECHNOLOGY

Food Production

- Green technology for Agriculture



Climate Engineering

- Reduction of CO2 in air (Carbon Sequestration)
- Cooling of Earth



Clean Energy Generation

- Bio Fuel
- Synthetic Natural Gas (Methane)
- Power through Municipal Solid Waste
- Solar & Ocean energy



Clean Environment

- Plastic tar road
- E-waste management
- Green Computing
- Liquid waste management & Bioremediation of floating oil



Herbs for Health



Wealth Generation

CLEAN GREEN ENERGY GENERATIONS – Sources

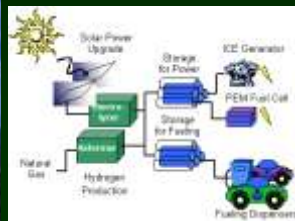
Solar Energy



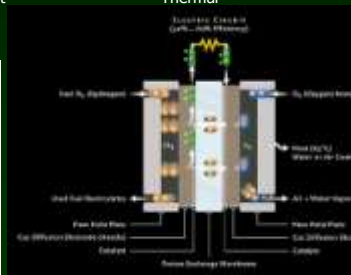
Energy from Ocean



Wind Energy



Hydrogen Energy

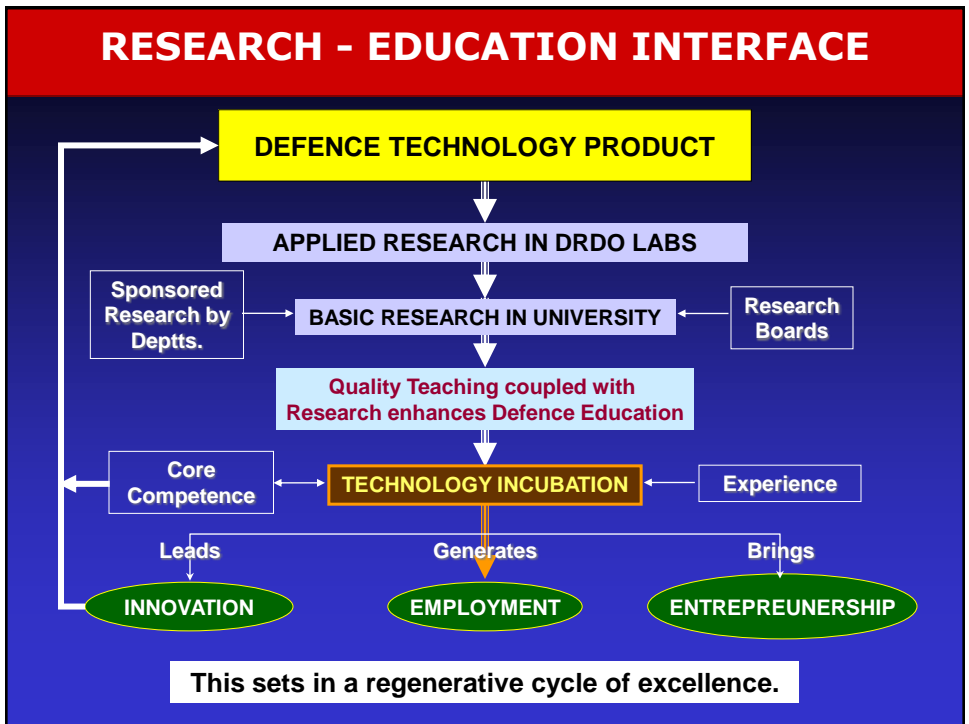


Fuel Cells

SPACE FRONTIERS

• SPACE TOURISM
• INTER PLANETARY TRAVEL

HUMAN RACE WILL GET OUT OF THEIR CRADLE – THE EARTH, TO EXPLORE NEW FRONTIERS IN SPACE, AS THE CHILD GETS OUT OF ITS CRADLE



VISION FOR THE INSTITUTION

- To become world class research based education in a cost effective manner, encouraging students through innovative programmes
- Provide support to mission mode R&D projects of the country becoming a partner in Nation Development
- Development of quality technical manpower in association with industries, providing competence in new product development
- Choice of syllabus that cater to the need of the rapid change in technology development and periodic updating of syllabus.
- Encourage the faculty for the concept of Teach-Research-Teach
- Establishment of centres of excellence and advanced studies in niche areas of science and technology
- Explore the possibility of international and national collaborations and joint ventures in the knowledge exchange programmes

QUALITY OF A TEACHER



A SCIENTIST WHO GAVE UP THE POMP OF A GLITTERING CEREMONY ASSOCIATED WITH THE HIGHEST HONOUR, BECAUSE HE FELT THAT HIS DUTY REQUIRED HIM TO BE BY THE SIDE OF THE STUDENT.

MESSAGE TO TEACHERS

“Success can only come to us by courageous devotion to the task lying in front of us. What we lack is perhaps courage, what we lack is perhaps driving force, which takes one anywhere. We have developed an inferiority complex. I think what is needed here today is the destruction of that defeatist spirit. We need a spirit of victory, a spirit that will carry us to our rightful place under the Sun, a spirit, which can recognise that WE, as inheritors of a proud civilisation, are entitled to a right place on this planet. If that indomitable spirit were to arise, nothing can hold us from achieving our rightful destiny.”



Sir C.V. Raman (1969)

Thank you

e-Mail : aspillai@brahmos.com
Web : www.aspillai.com