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5G TECHNOLOGY IMPACT ON GEO-INTELLIGENCE

Speaker - Lt Col Vivek Gopal 

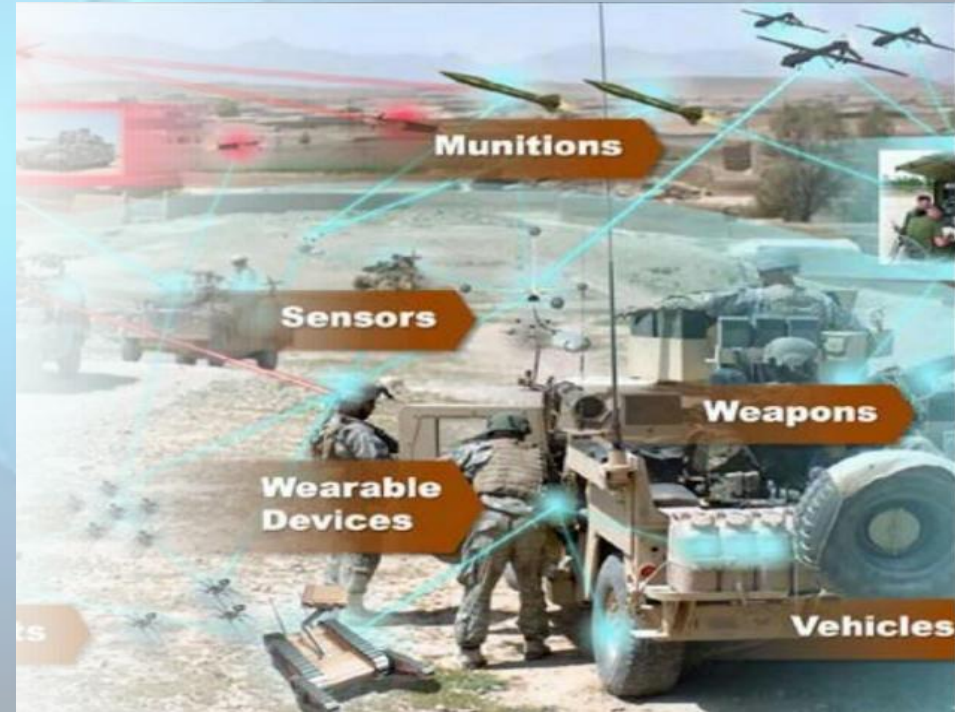


Image Credit: (Left) – satellitetoday.com (Right) – blog.studyiq.com

GEO-INTELLIGENCE & 5G

- DATA RATE - eMBB
- LATENCY - UrLLC
- IoT (read IoMT/IoBT) - mMTC

'INTELLIGENCE' OBTAINED FROM
IMINT, SIGINT, MASINT, and HUMINT



DERIVATIVES & ENABLING TECH

- Speed of transmission of data (UrLLC)
- Data Chunk (eMBB)
- Network/Mesh of Sensors (eMBB & mMTC)

Shorten the sensor to effector loop

*Info Provide
Info Deny
Info Deceive*

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY

WHAT IS GEOINT?

UNCLASSIFIED

GEOINT is composed of information layers, which answer such questions as...

- ❖ Where am I?
- ❖ Where are the friendlies?
- ❖ Where are the enemies?
- ❖ When might they move?
- ❖ Where are the non-combatants?
- ❖ Where are the obstacles, natural or man-made, and how do I navigate among them?
- ❖ What is the environment?
- ❖ What does it mean?
- ❖ What is the impact?

UNCLASSIFIED

THE UNITED STATES OF AMERICA

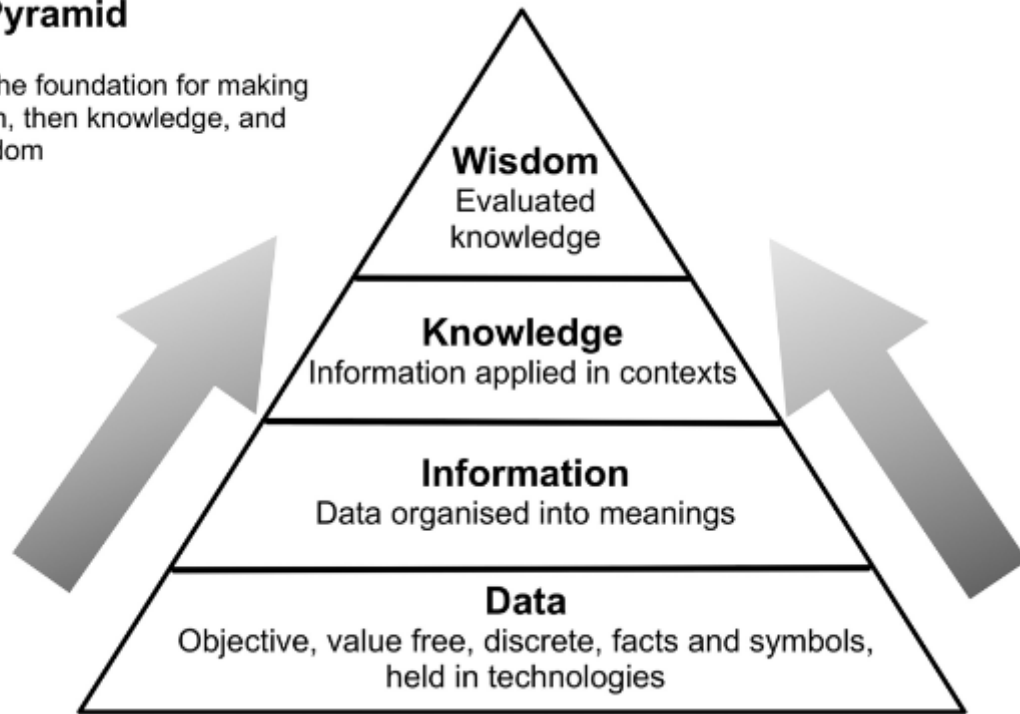
Source:

https://en.wikipedia.org/wiki/Geospatial_intelligence

DIKW FRAMEWORK FOR GEO-INT WITH 5G

DIKW Pyramid

Data are the foundation for making information, then knowledge, and finally wisdom



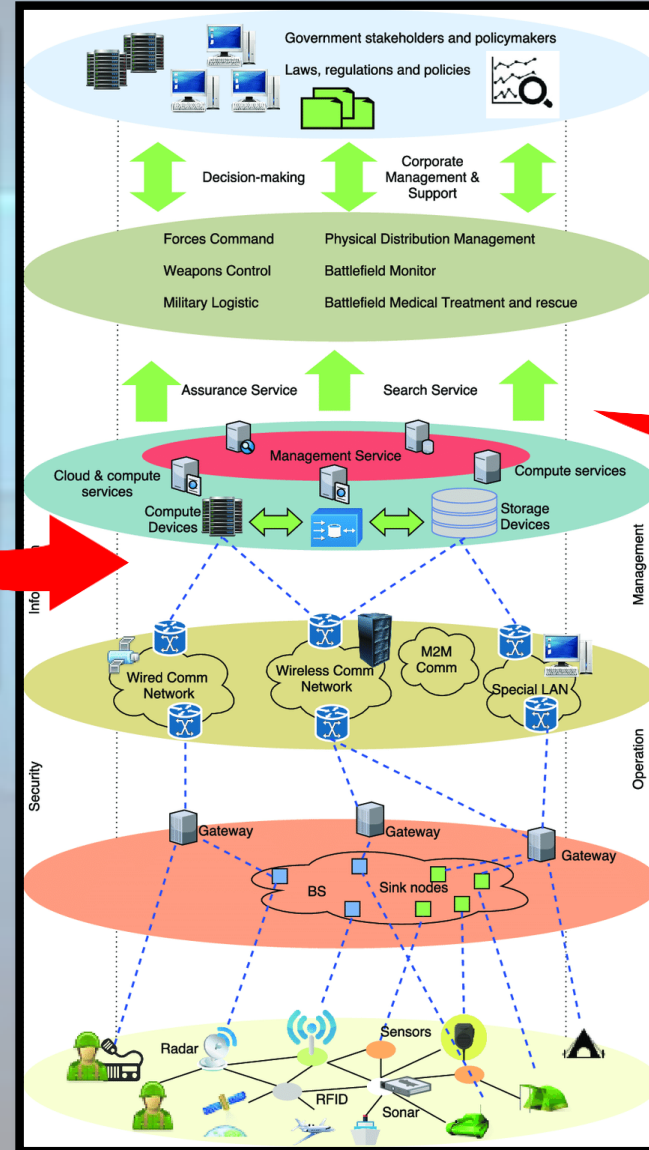
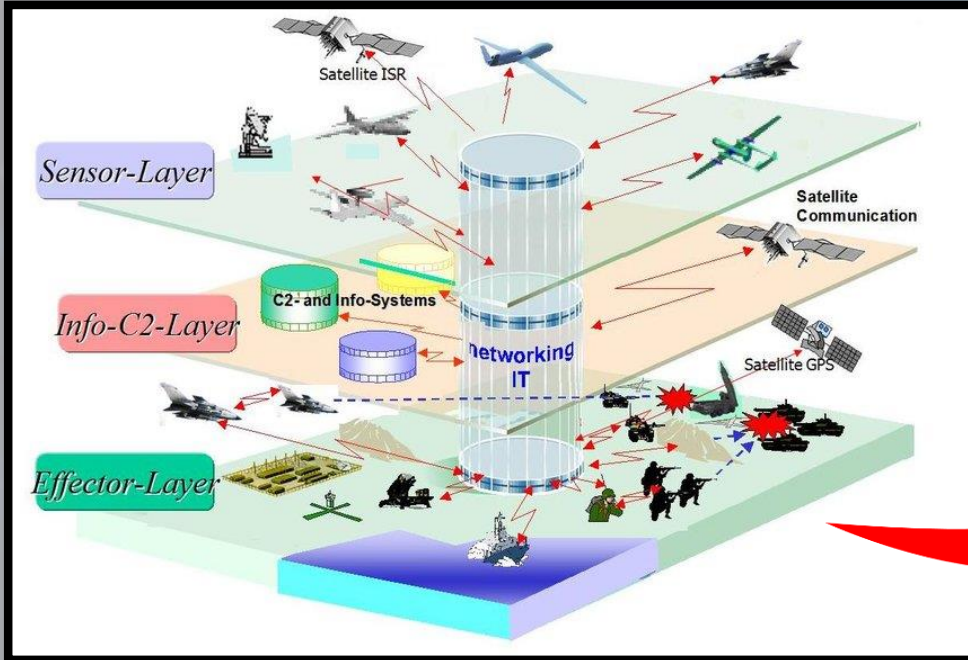
DIKW emphasizes linear input/output processes, in which raw data inputs, digital storage and information organization, and knowledge end-product outputs are sequenced to serve decision makers.

- Wisdom – Rational & informed decision making
- Knowledge – information that has been contextualized and made actionable for decision makers
- Information – Intelligence derived from raw data (coarsely filtered)
- Man-machine teaming (MuMT)
- Data – is the new oil – Generated data – Sifted, Collated – Speed of essence – AI & ML – 5G link explored
- Obtained from plethora of resources – Link all the resources on a secure 5G network – ? Private 5G Slice

Source: Kelly, Paul Richard. 2018. "An Activity Theory Study of Data, Knowledge, and Power in the Design of an International Development NGO Impact Evaluation." *Information Systems Journal* 28 (3): 465–88. <https://doi.org/10.1111/isj.12187>.

HYPOTHETICAL SCENARIO

Assumption – IoT/MIoT & Embedded Sys depicted interchangeably



RELEVANT RESEARCH AREAS

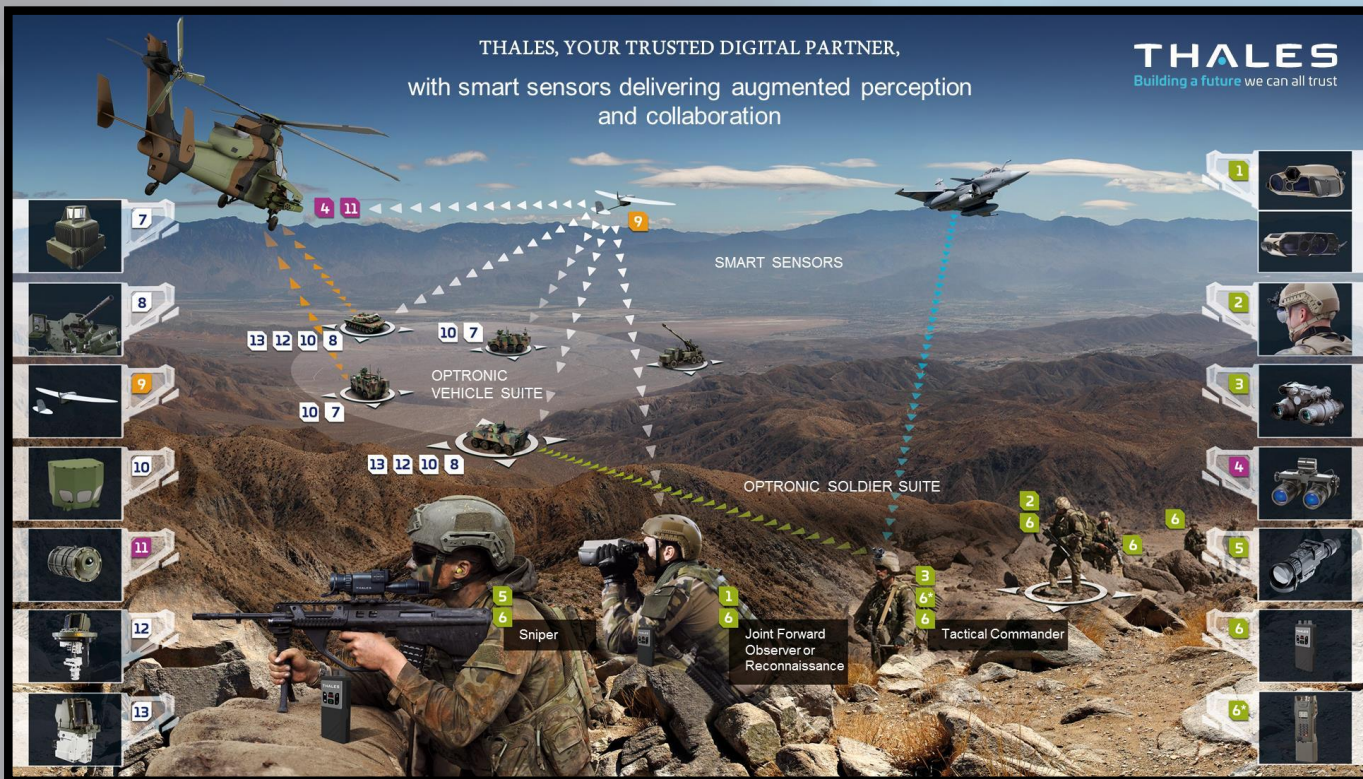
- 5G IN A BOX/ LTE OVER SATELLITE
- HANDHELDS / PDA
- UNIFIED COMN SYSTEM*
- PLATFORM & VENDOR AGNOSTIC SYSTEMS

* Joint Waveform Interoperability - Gopal, V., 2021. Joint waveform interoperability system (JOWIS) – Common Tactical Data Links For The Force Of 21st Century. [online] Cenjows.in

POTENTIAL - SCENARIO OF A FUTURE BATTLE FIELD

Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance

Cognition – C6-ISR ??



- Terrain Information
- PNT Signals for Blue Force Tracking & Pinning/ location fix the adversary
- Sensor -identification of target - Collate own data- multiple inputs
- Planning Ops on-the-fly (COE/ COP)
- Vectoring Strike Packages - Joint Operations
- Secure transmission of data

ENHANCED ISTAR - DATA FLOW TO COMMAND POSTS - COMMAND POST TO CROSS FUNCTIONAL COMBAT TEAM (PIN POINTED ARTILLERY STRIKE) - STRIKE - BDAR

POTENTIAL - SCENARIO OF A FUTURE BATTLE FIELD

The infographic features a central image of a soldier in full combat gear, including a helmet, night vision goggles, and a rifle. Blue arrows point from various pieces of equipment to their respective battery specifications listed around the soldier. The equipment and battery details are as follows:

- AN/PVS 14 (Night Vision)**: (2) AA, 106 lbs/.04 watts*
- Mark VII**: (1) 3.9 V lithium, 256 lbs/.167 watts*
- MBTR**: (8) BB 521, 6.4 lbs/5.33 watts*
- Sure Fire Light**: (6) CR-123A, 222 lbs/.219 watts*
- Mag Lite**: (2) AA, 106 lbs/.019 watts*
- DAGR**: (24) AA & (1) 1/2 AA, 1.3 lbs/.729 watts*
- Head Set**: (2) AA, 106 lbs/.019 watts*
- PEQ-2A**: (2) AA, 106 lbs/.011 Watts*
- HTWS (Night)**: (12) AA Lithium, 384 lbs/.68 watts*
- M68 CCO (Day)**: (1) DL 1/3N, .007 lbs/.00006 watts*
- LMR**: (8) 3600 mAh NiMH, 6.4 lbs/1.51 watts*
- P-Beacon**: (1) 9V, 1 lbs/.049 watts*

Total: 7 types of batteries, 70 batteries, 16 lbs; 9.16 watts

*Average Watts per 72 hours



Viasat – Encrypted Radios for Communication

UNMANNED AUTONOMOUS SYSTEMS – 5G

5G autonomous military solutions

Showcased by iMUGS Consortium at LMT-led demonstrations



LMT's Battle Management System (BMS)



Imi



LMT deployable base station with 4G/5G commercial network

Imi



LMT's BMS-equipped command post in KMW APC DINGO

KMW Imi



LMT integrated commercial 4G and 5G networks with Bittium Combat radio and 4G/5G tactical communications for data transfer

Bittium Imi



LV-Teh modular, multifunctional combat support platform

Imi



Rantelon IED (improvised explosive devices) jammer

Rantelon



LMT gunshot detection and source recognition audio sensor

Imi



Electronic Communications Office of Latvia - Signal Intelligence (SIGINT) solution "SKUDRA" for radio frequency monitoring to detect the opponent's radio transmitting equipment

Imi



Rheinmetall's ROSY smoke/obscurant protection system

RHEINMETALL



FN Herstal remote weapon station

FN HERSTAL



SRC Brasa Natrix unmanned combat support platform

SRC BRASA



Milrem Robotics' unmanned ground vehicle TheMIS

MILREM ROBOTICS

5G
3G4G

T1

Integrated Modular Unmanned Ground Systems (iMUGS) consortium is a 13-party collaboration focused on standardising a European-wide ecosystem for aerial and ground platforms, command, control and communication equipment, sensors, payloads, and algorithms

- Linked to **Battle Information Management System** for displaying the data of the payloads and as a command system for scenario execution
- Linked to **Intelligence Surveillance Reconnaissance (ISR)** system for performing aggressive **fire detection and source recognition**
- The ISR system 'Skudra' for performing SIGINT
- Wheeled vehicle DINGO 2 as a command post from which the mission is led

Alternative communication networks were used by the troop and an unmanned ground vehicle, in scenarios that included switching from a tactical network, provided by 4G and 5G networks.

Source: <https://www.telecomsinfrastructure.com/2022/01/5g-for-defence-and-autonomous-military.html>

EXAMPLE OF GEO-INTELLIGENCE & 5G

ALLIED SYSTEM FOR GEOSPATIAL INTELLIGENCE (ASG) PROGRAMME

RAPID EXPLOITATION FOR MISSION SUCCESS

Raytheon UK is enhanced Geospatial Intelligence for the UK Ministry of Defence (MOD) by delivering the first phase of the Allied System for Geospatial Intelligence (ASG) Programme.

Source: <https://www.raytheon.com/uk/capabilities/products/asg>

PICASSO is the MoD programme that delivers and sustains UK Defence's Geospatial Intelligence (GEOINT) capability, which is fundamental to enabling commanders and military forces to understand, plan, navigate and target.

Mobile Integrated Geospatial-Intelligence System (MIGS): MIGS, a robust, deployable system that provides organic communications including classified computer systems, video teleconferencing, and phone service. MIGS has contracted bandwidth to provide wide coverage throughout continents.

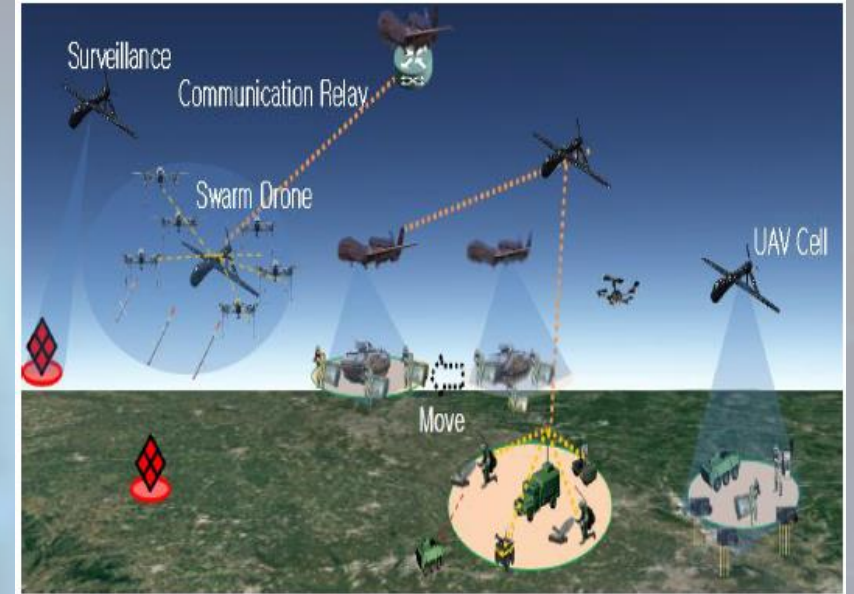
Source: National Geospatial Intelligence Agency, Basic Doctrine, July 2006



USE CASES OF GEO-INTELLIGENCE & 5G

Int Prep of Battlefield – Tasking , Processing, Exploitation & Dissemination

- Accurate Location Fix
- Digital Surface Models – relayed to commanders – better planning of ops
- Terrain peculiarities highlighted
- Planning communications for ops – inter-visibility, troop density
- Asset visibility across theatres
- Logistics
- Change Detection & Threat Classification – 2CMV or 3D Flythrough
- Unmanned Weapon Systems
- Threat Simulation - Wargaming



Concept of Unmanned Weapon System

Source: 'A Plan for Future Battalion Tactical Network with 5G Network', *Journal of Digital Contents Society*

Vol. 22, No. 3, pp. 537-545, Mar. 2021,

<http://dx.doi.org/10.9728/dcs.2021.22.3.537>

5G in Space - NTN

THREATS TO 5G/ GEOINT

- Battle for Data Supremacy - Malware Can Attack Devices - Software Defined Radio - Vulnerable Radio Infrastructure & Core Network Can Be Attacked Via Interconnects With Compromised Telcos.
- **DEMOCRATISATION OF TECHNOLOGY** - Non-state actors (including social media giants)
- **INTEROPERABILITY** - Spectrum & Disaggregation Issues



Soldiers transmit position location information during an exercise

Source: Nationaldefensemagazine.org, 2021



SWOT ANALYSIS

OPPORTUNITIES

- **COMMUNICATION PROTOCOLS – OPEN GATEWAYS** – Aim : the quick, ad hoc establishment of secure, local networks based on 5G technology- let forces take sensor data from any platform in the theater and make it accessible to any shooter, no matter how the platform and the shooter each connect to the network.
- GIS Information shared over **HetNets & Terrestrial or NTN**
- **NEW COMPUTATIONAL MODELS** – Need to incorporate resource constraints, failures (individual components may fail by shutting down to conserve energy, for example), new data models, trust
- **EVOLVED REALTIME SOFTWARE** – OS & OTA UPDATING
- **SYSTEM HEALTH MONITORING & SELF HEALING NETWORKS** – High Availability & Fault Tolerant
- **Adhoc GIS Network** by airdropped, Aerial delivery of sensors – self destruct after combat pulse?

NEW OPPORTUNITIES & ALLIED THREATS

THREATS & WEAKNESSES

MORE NETWORKED WE ARE – LARGER THE ATTACK SURFACE

- ELECTRONIC WARFARE
- HACKING – CYBER THREATS – MITM ATTACKS
 - NETWORK ACCESS CONTROLS
 - ADHOC ROUTING PROTOCOLS
 - DISTRIBUTED PROCESSING vs ON THE CHIP COMPUTATION
- MUTUAL INTERFERENCE – DENSE BATTLESPACE – WIRED & WIRELESS COMMUNICATIONS
- MULTI PATH PROPAGATION - **TRADE OFF** – INTENSITY VARIES INVERSELY FOURTH POWER OF DISTANCE
 - STRONG DECAY ALONG THE GROUND HELPS IN FREQUENCY REUSE
- ENERGY CONSUMPTION

WAY FORWARD/ APPROACH PRIORITISATION

TREND 1: PLANNING TOOLS FOR RESOURCE INTEGRATION

TREND 2: POST SPECTRUM ALLOCATION – MERGE GIS VERTICAL WITH 5G ROLL OUT SIMULTANEOUSLY – BANDWIDTH ALLOCATION – DECIDE ON THE NETWORK SLICE

Gopal, Vivek. 2021. "Militarisation of 5G: A Necessity for the Forces." Centre for Land Warfare Studies. https://www.claws.in/static/IB-291_-Militarisation-of-5G.pdf.

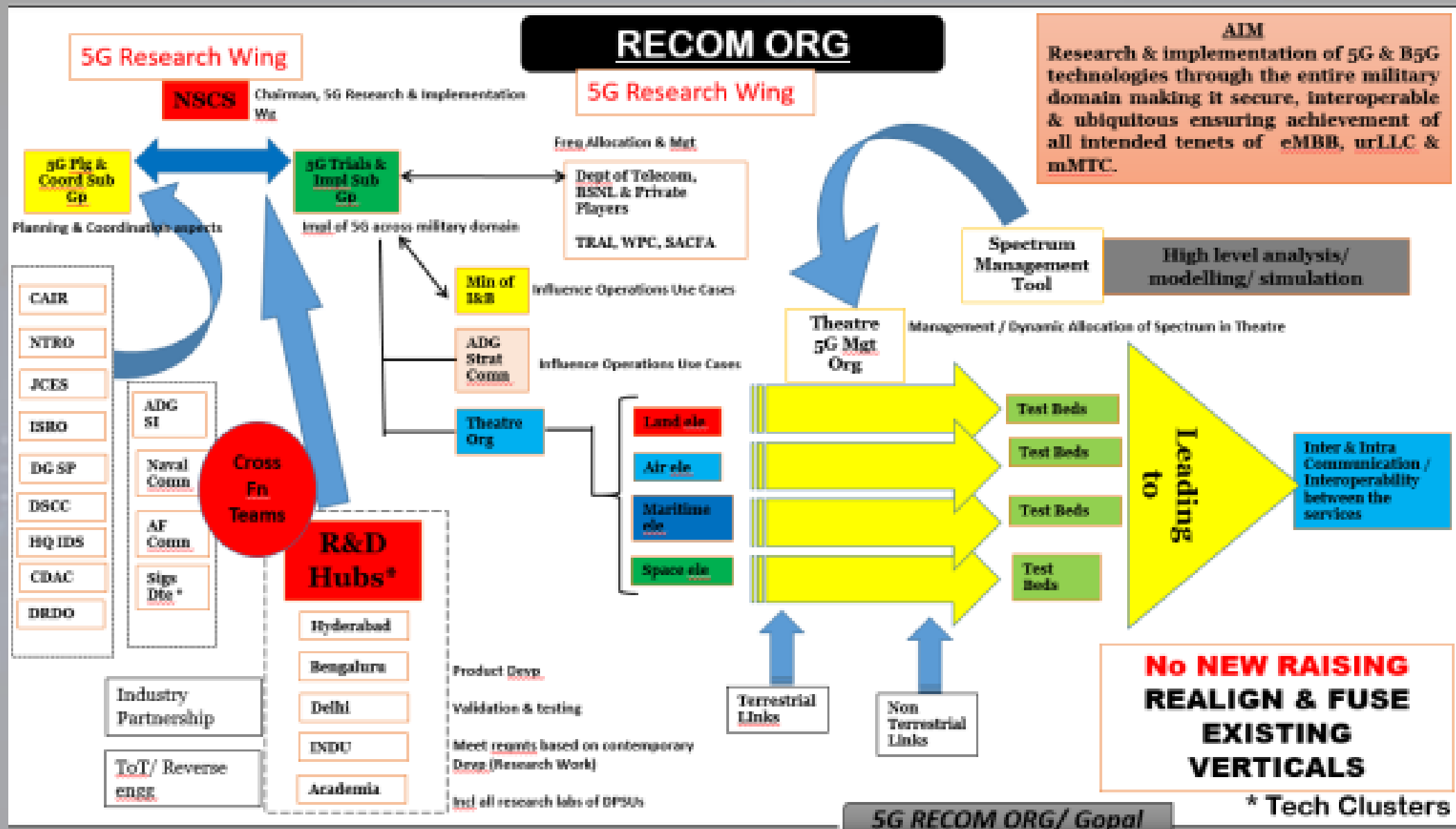
TREND 3: OPEN ARCHITECTURE – INTEROPERABILITY & PLATFORM/ VENDOR AGNOSTIC

TREND 4: COMPUTING POWER – LEVERAGE AI RESIDING ON GPGPU

TREND 5: SPATIAL DATABASE MANAGEMENT SYSTEMS DEVELOPMENT

TREND 6: BROWN FIELD APPROACH – NETWORK DENSIFICATION – QoS

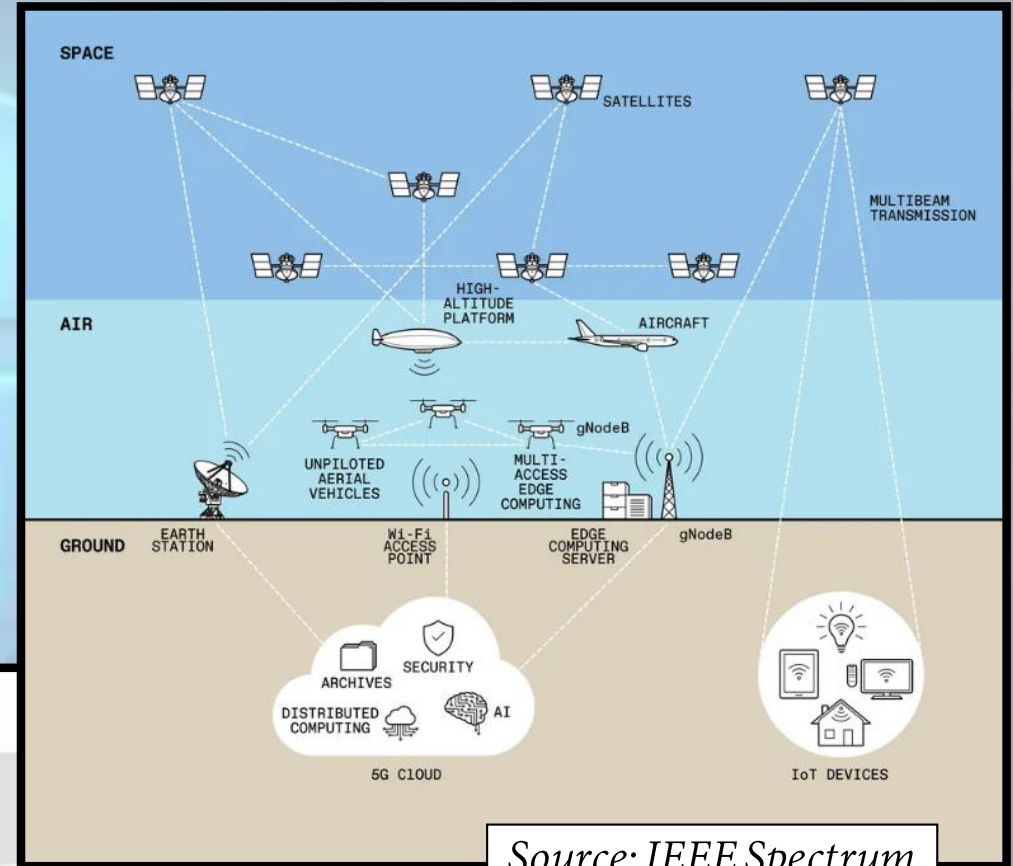
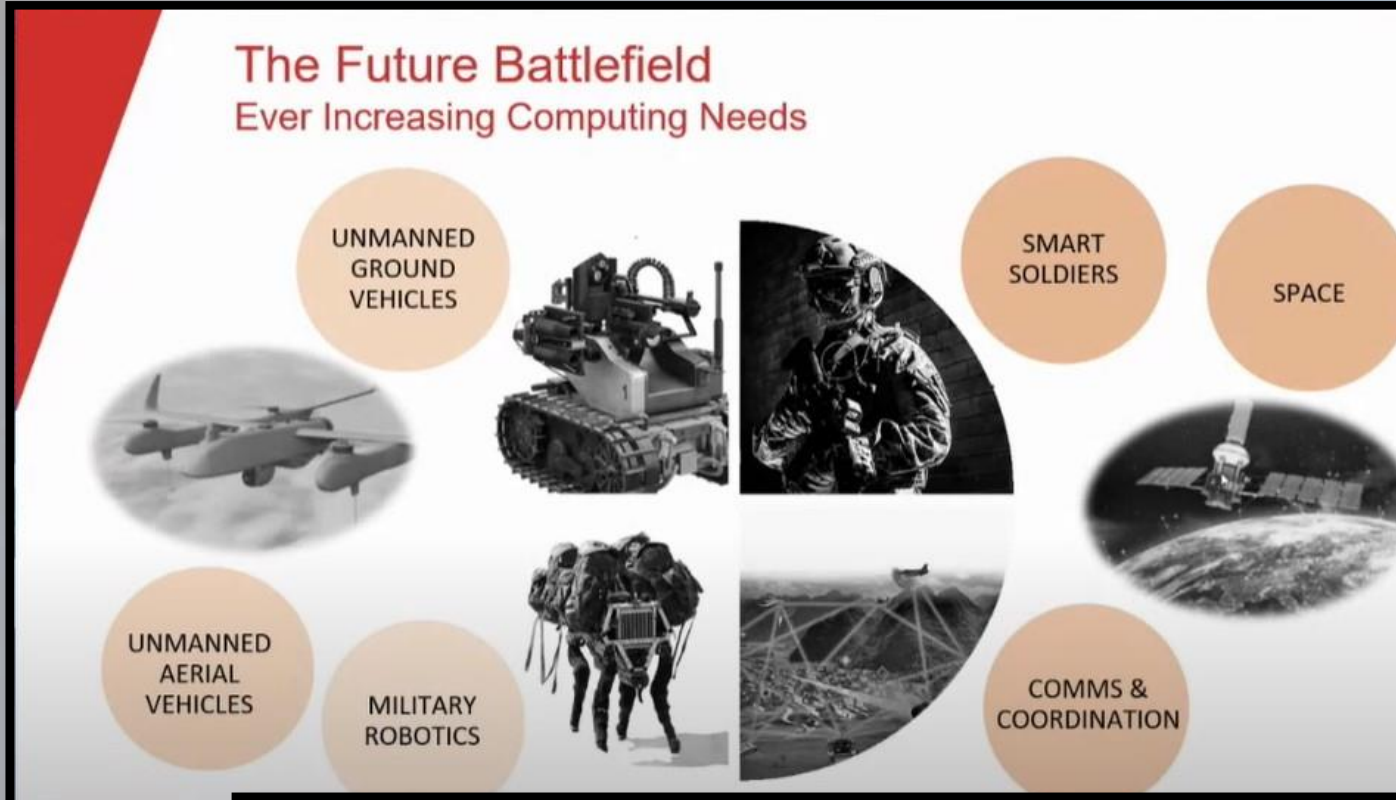
TREND 7: SEPARATE THE HUMAN COGNITION ASPECTS FROM ML/AI



Source: Gopal, Vivek. 2021. "Militarisation of 5G: A Necessity for the Forces." Centre for Land Warfare Studies. https://www.claws.in/static/IB-291_-Militarisation-of-5G.pdf.

IN ESSENCE

The Future Battlefield Ever Increasing Computing Needs



Increased Computing in Shrinking Footprints (SWaP-C)

More for Same

- Integrate more functionality into the same component or sub-system, without increasing its SWaP-C

Same for Less

- Reduce SWaP-C of existing component or sub-system, without changing its function

Source: IEEE Spectrum

TO CONCLUDE



5G GEOINT SYSTEM - PROPOSED

- **Data Aggregation Centres** – Earmarked locations & Vehicle Based Terminals (Scalable) – ‘Defence Slice based’.
- **Hybrid Base stations** – tactical Gateways – High Speed connectivity – Ae assets, Space, terrestrial networks – All relay information
- **Planning & Management Tool** – Rights Based Resource Allocation
- **National Grid** for Information Exchange – Visibility across theatres
- **Information Dissemination Systems** – Exploit 5G/ Satellite/ Aerial Assets (Mega Constellation – Nanosats)
- **PDA/ Compatible handsets**
- **Remote Replication of Database** – Contingency
- Geocoding framework
- Digital Twin Generating Centre

RETHINK – RESET – RECALIBRATE - REINVENT

THANK YOU