



TERCOM
人を育て未来を創造
Develop My Talent,
Create Our Future

JGSDF 2040

***Leading Innovation
of the JGSDF***

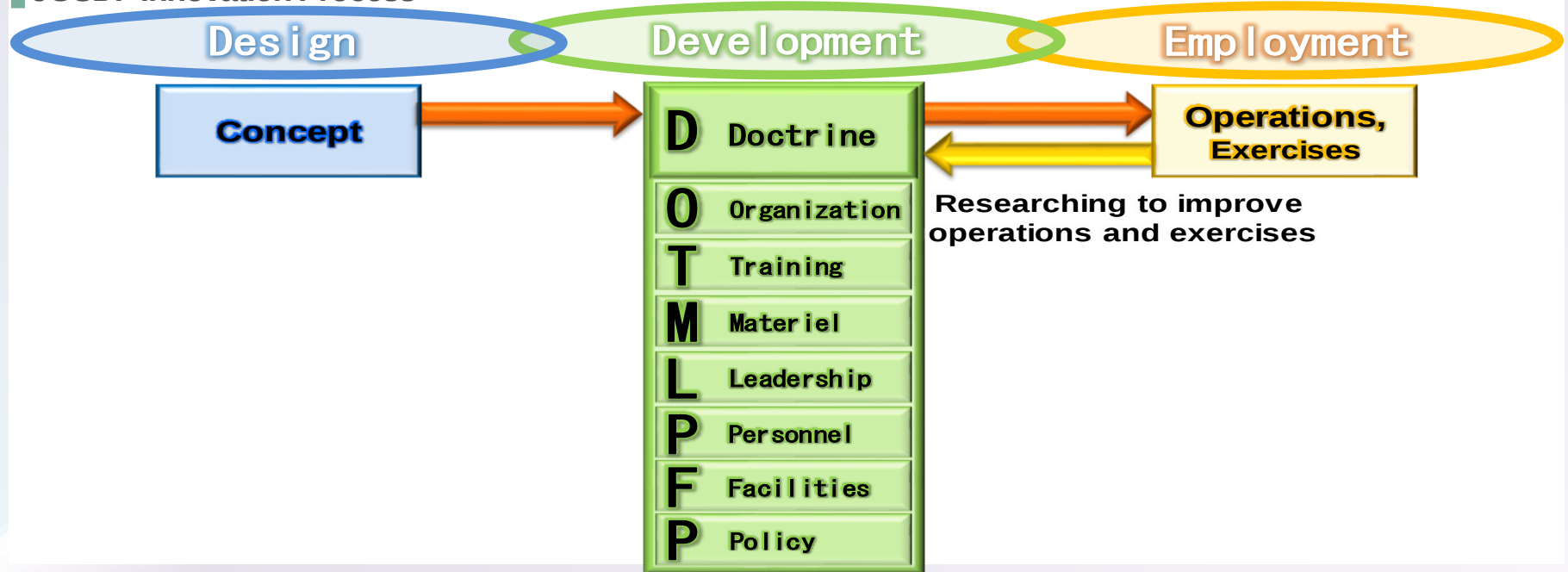
This document is research paper by TERCOM and it does not mention JGSDF's official perspective.

Research of “Future Operations and Ways of fighting of JGSDF around 2040 ”

Aim of this Research

- As TERCOM , a think tank of JGSDF, we are thinking about JGSDF's future concept.
- For contributing to proceed “JGSDF Innovation Process”, we research and discuss with various organizations, and publish our report.

JGSDF Innovation Process



Methodology	Based on strategic environment, advanced scientific and technological trends, and developments in military theories of various countries around 2040, we consider direction of future fighting and exemplify new equipment and technologies to acquire capabilities to realize the ways.	
Item	1 Strategic environment around 2040 2 Scientific and technological trends 3 The future characters of warfare	4 Military theories 5 Direction of Future Warfighting 6 New equipment and technologies to acquire capabilities in the future , etc.

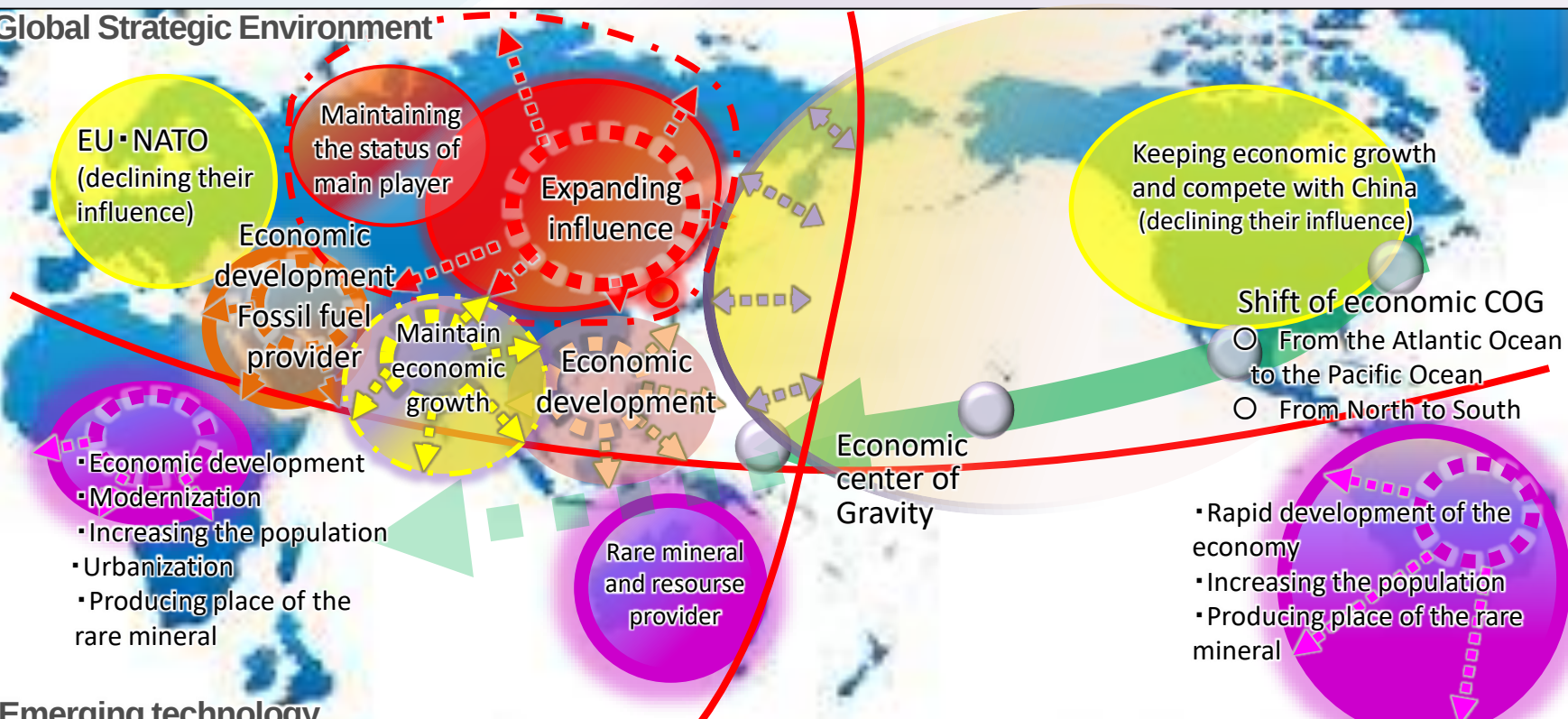
Trends of Global Strategic Environment around 2040

3

Trends of strategic environment

- The global order is changing from Global West centric to multiple and complex relations. Each different political systems, social, and cultural actors will be cooperating, competing and conflicting at various issues. Their group members will be different at each issues. Emergence of developing countries promote this change. In the future, there will be no single global power. Many issues will be hard to manage because of increasing interdependence and continuing globalization.
- The tendency of globalization will remain, especially information, data, communication field because of high tech society. On the other hand, political and important supply chain fields will be direction to de-globalization and shaping some blocks for keeping state's autonomy and legitimacy.
- Technological advances in AI, robotics, energy, nano and bio-technology, space, and information and communication fields will have a significant impact on the operational picture.

Global Strategic Environment



Emerging technology



Emerging technology and affects to War-Fighting Functions

Summary			With the advancement of science and technology, the use of AI, information and communication technology, and non-kinetic means are increasing. Therefore, each War-Fighting Function around 2040 will change dramatically.	
Tech		Element	Function	Tendency
AI		Information mass processing, decision making , unmanned	C2	AI and information and communication technologies will improve intelligence and communication capabilities.
Robotics		Human replacement, swarm control		
Nano		Reinforced material , micro sensors	Information	Emergence of new means of information gathering and analysis through AI and other means will increase importance of cognitive abilities.
Bio		Regenerative medicine (some organs), artificial blood		
Neuro		Machine control by human brain waves, reading emotions from human brain waves		
Quantum	PC	Ultra-high-speed information processing, cryptanalysis	Intelligence	Developments of sensors, UAVs, and satellites will improve the ability to collect and share target information.
	Crypt	Highly secure encryption		
	Sensor	High-precision sensors (positioning, detection)	Strike	Means of striking , including non-kinetic, such as energy weapons will be increased. Long-range firepower will be achieved.
ICT		High speed, high capacity, low latency, many connections		
Energy	High power laser	Low cost, instantaneous engagement, continuous engagement		
	HPM	Low cost, instantaneous engagement, destruction by non-physical means		
	Railgun	Instantaneous and continuous engagement		
	Power storage	High energy density next-generation batteries		
	Generation	Power generation from waste, ultra-compact power collection	Movement and maneuver	Means of maneuver and space to be utilized will be diversified due to elimination of needs for strategic maneuvering of long-range firepower and developments of unmanned vehicles.
Manufacture		3D printing		
Space	SAT Com	Large tolerance of satellite		
	Collect Info	Precision positioning	Protection	Developments of disguise, deception and multiple protection techniques actively nullify strikes.
	Obstruct GNSS	Satellite use jamming, EM attack to ground stations		
EMS	Sensor	Miniaturization and high performance of various sensors	Sustainment	AI, drones, and energy generation will improve human and organizational resilience.
	Deception	Location spoofing, decoy		
Fire	Missile/Rocket	Longer range, higher speed, higher power		
	Heavy caliber	Longer range and higher power		
Mane-uver	Air	eVTOL , stratosphere maneuver		
	Under water	USV,UUV		
Prote-ction	Multi-layered	Active protection		
	Deception	Visible decoys, EM decoys,...etc.		

(Originally created by TERCOM based on "Defense Technology Guideline 2023(Previous section)", etc.)

The Future of the Characters of Warfare(1/3)

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Transformation of Battlefield

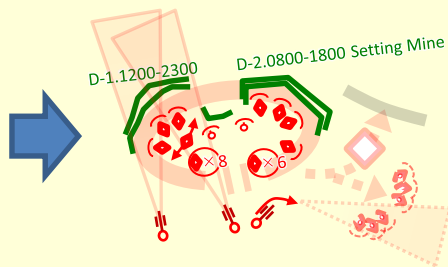
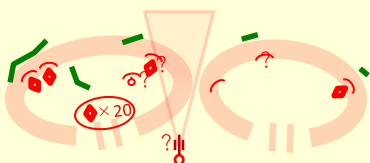
Summary

- The future battlefield will be transformed as more extend, integrated, and accelerated.
- The three main reasons for this are
 - (1) The visualization of the battlefield and information sharing.
 - (2) Expansion and contraction of the battlefield.
 - (3) Changes in the relationship between space and time.

Visualization of battlefield

【Current】

- Less info
- Estimation based enemy analysis

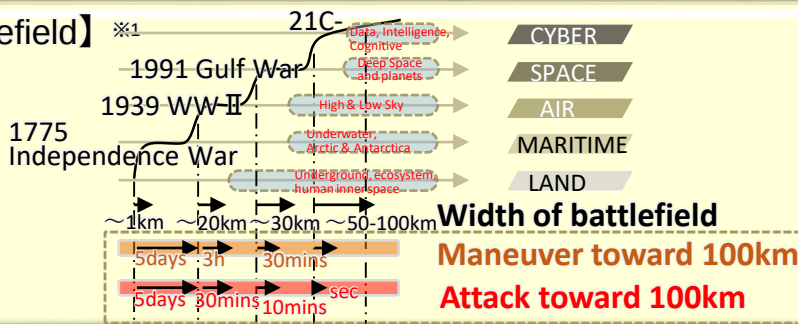


【Future】

- Realtime monitoring
- Analyzing past data and assuming enemy's next action.

Expansion & Contraction

【Expanding the Battlefield】※1

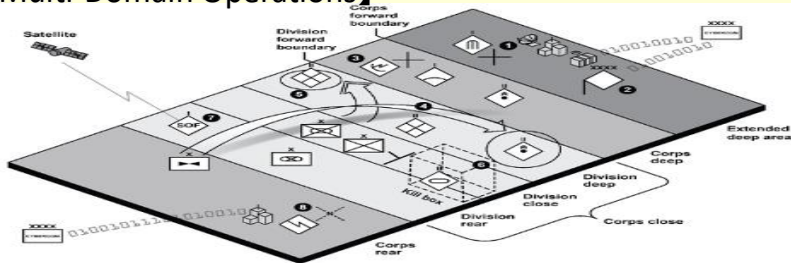


- The domain and width of battlefield is expanding.
- The time to reach is decreasing by high speed movement and long range fires.

※1 L.gen Eric Wesley, US. Army.

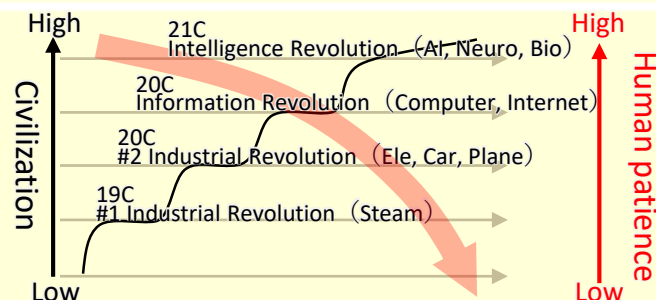
Changing relation between Space & Time

【Multi-Domain Operations】※2



※2 “FM-3-0 Operations”, US. Army HQ.

There are no frontline and each side engage wide area.



Improving Quality of life lessen human patience.

The Future of the Characters of Warfare(2/3)

6

Transformation of relationship between Strike & Protection, Fire & Move, Attack & Defense

Summary	- It is difficult for each actors to take advantage or predominant because of increased firepower effectiveness, redundancy, and web-structured military organization. - These factors also alter the relationships between striking and protection, fire and maneuver, and attack and defense. - The competition to adapt military systems extends not only to the software but also to the hardware, like optimizing weapon capability, even for short-duration operations.		
Strike has advantage Protection	【Range & Lethality】 ● 2000s ● 2020s ● 2040s	【Survivability of Onion】 It will be hard to protect by ordinal methods.	【Kill-Chain to Kill-Web】 - Kill Web decreases structural vulnerabilities. - Quantity is more emphasized than Quality.
Relations between Fire & Move, Attack & Defense	【Engagement】 - Each engagement area will be extended. - The ground engagement area will not change so much.	【Relationship between Attacker & Defender】 - The Maneuver element risks not reaching target position.	- Each actor seeks to avoid adversary's detection and fire.
Competition of adaptation	【Competition of Software & Hardware Adaptation】 - Weapon will be optimized and modified in less time. - Each actor compete with not only software adaptation but also hardware.	【Using Positive feedback system】 - Generally every organization works based on negative feedback. - It's useful to use positive feedback system for controlling adversary.	

The Future of the Characters of Warfare(3/3)

7

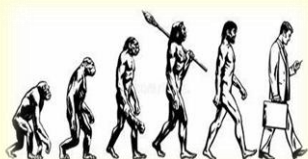
Expansion of human and organizational capacity

Summary

- Human abilities will improve as the human body and brain are elucidated, and human senses and values will change along with these changes.
- Changing the ways of cooperation among humans, human forms, and the roles and relations man-machine teaming

Improving human ability

【Importance to learn Anthropology】



- Human stopped evolution until Neolithic era.
- We also need to know unconscious mechanism.

【Expanding the ability of sense, brain, communication】



- Haptics enable to obtain new sense & experience.
- Tech enhances human ability of sense, brain etc...

Transformed human and using Avatar

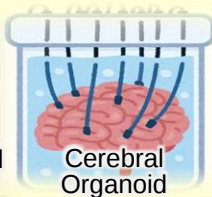
【Transformed human】



Remote Control
(1 on 1)



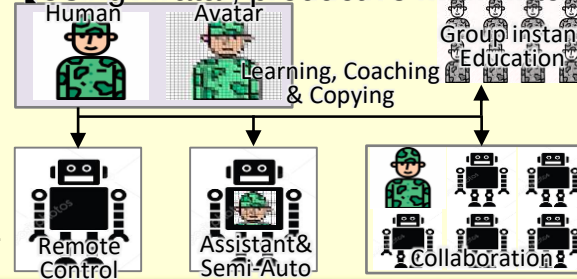
Sub-arm controlled
remotely (2 on 1)



Cerebral
Organoid

- Tech change definition of "Intelligence" and "Human".
- Machine-sense, trained Organoid

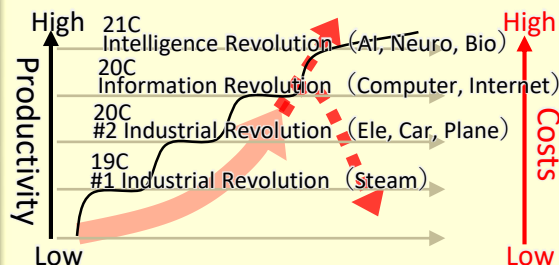
【Using Avatar, productive Man-Machine Teaming】



- Virtual assistant & Avatar help human tasks.
- Remote control & behavior copy enable Man-Machine Teaming.

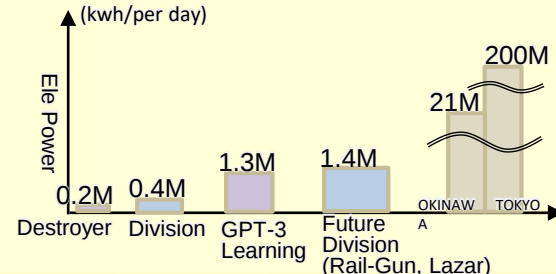
Productivity & Costs

【Increasing productivity & costs】



- Productivity will continue increasing.
- Will singularity come or not?
- Will running cost decrease?

【Increasing Electric power requirement】

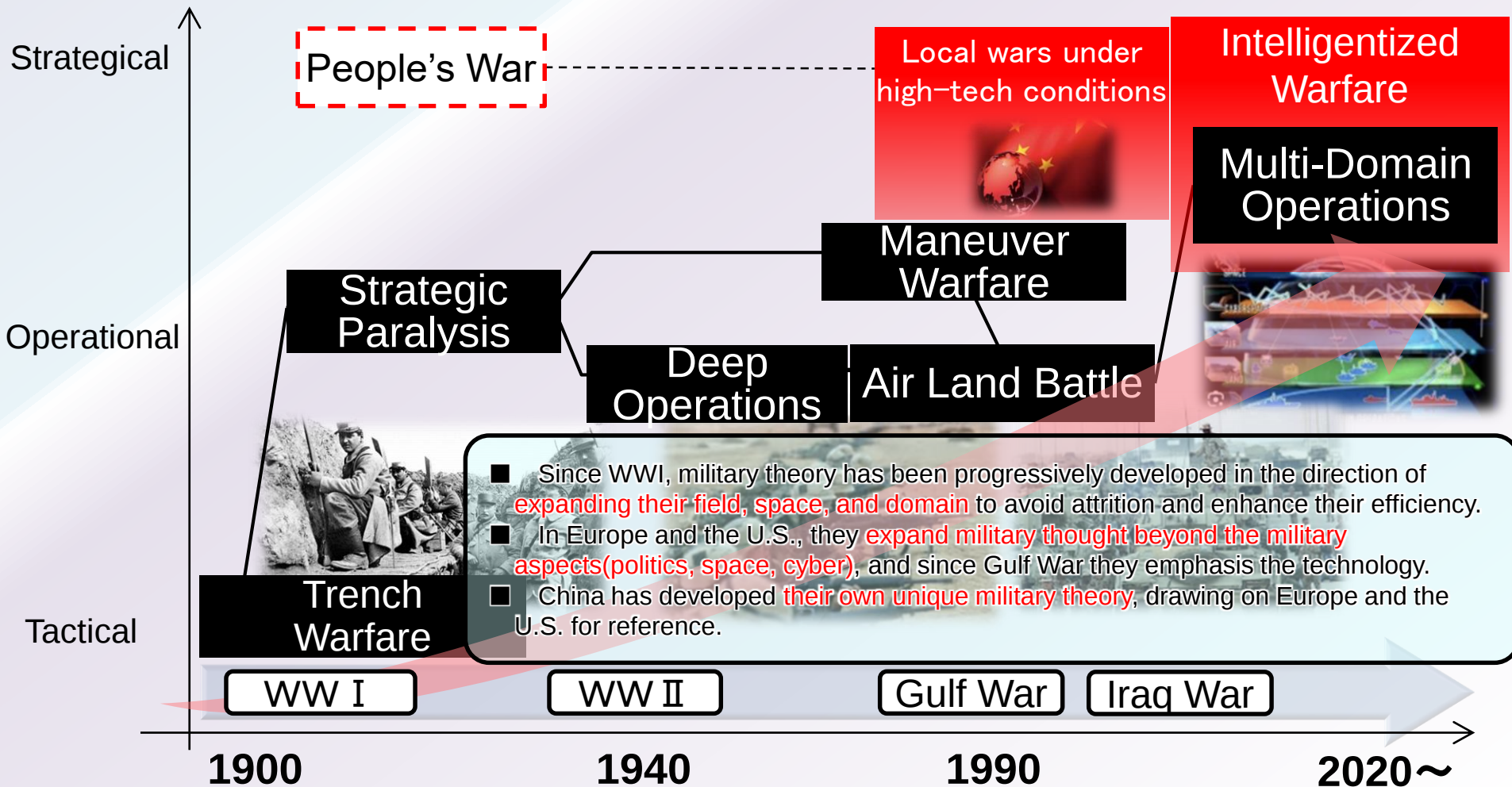


Developments of military theories after WWI

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Summary

- Since Industrial Revolution, military theories have been developed dramatically in various countries. Especially, after WWI, the field of military issues were regarded as “**not the field of soldiers own.**” In addition, issue of **military and security field, domains and measures have been expanding** sequentially.
- Each actors seeks to their advantage by establishing their own unique solution, especially using asymmetric means. **We also need to think about our own military theory and thought** based on our unique history and strategic culture.



Defeat Mechanism(1/2)

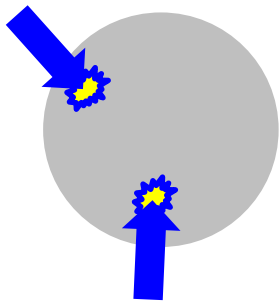
Summary

- There are two conventional defeat mechanisms: "Attrition," which attempts to defeat the enemy by **physically destroying** the enemy, and "System Disruption," which attempts to defeat the enemy by **destroying the enemy's core and severing critical networks**.
- The conventional system collapse approach will become more difficult as networks become more interconnected and redundant in the future. For this reason, two techniques ("dislocation" and "disorientation") are introduced to the traditional approach with the goal of leading the adversary's system to collapse more efficiently

Conventional Defeat Mechanism

Attrition

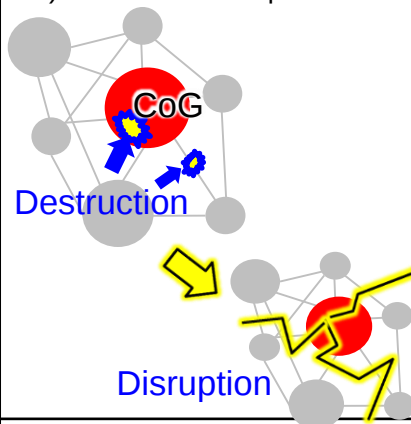
Ex) -Trench warfare(WW I)



Destruction

- Destroy enemy directly.
- Counting accumulation of killed soldiers or destroyed equipment.

Ex) – Gulf War - Iraq War



Disruption

- Regarding enemy as whole system and striking CoG(Center of Gravity) or cutting links.
- Evaluating enemy's organizational paralysis.

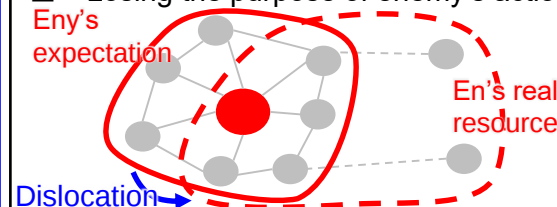
Extended Defeat Mechanism

System Disruption

Dislocation

- Losing the purpose of enemy's actions by changing boundary.

Eny's expectation

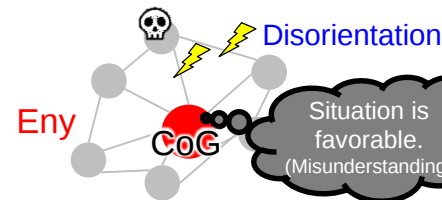


En's real resource

- Changing enemy's structure or elements of whole system.
- Indirect-approach, circumvent, changing vital battlefield, deception

Disorientation

- Misleads enemy's commander about situation and inhibits normal decision making.



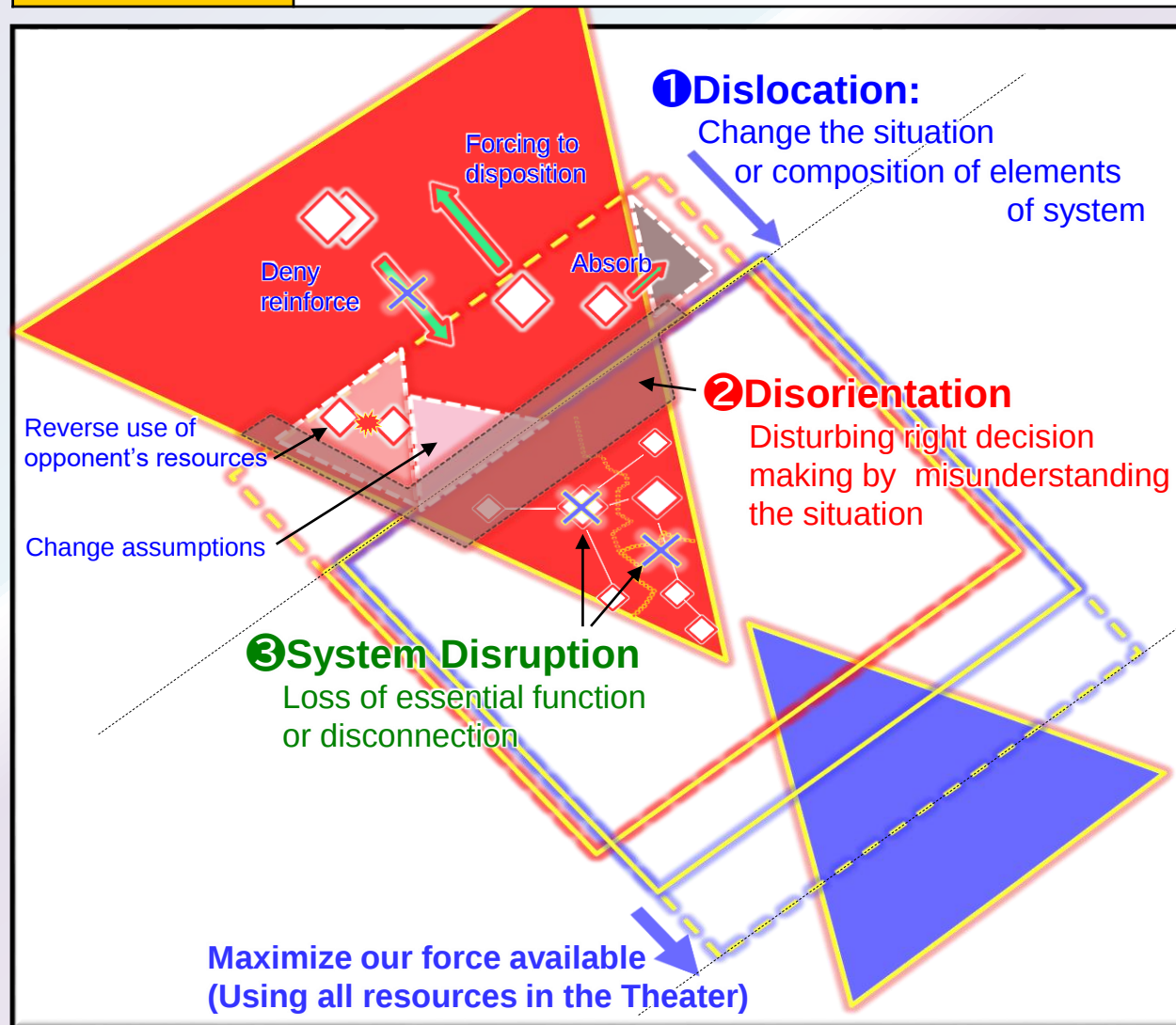
- Misleading enemy commander into thinking a favorable is unfavorable or vice versa.
- Cyber attack, EW, false signal, overfitting.

Defeat Mechanism(2/2)

10

Specific measures
for each method
of defeat
mechanism

- Specific measures for realizing the defeat mechanism include "Dislocation", "Disorientation", "System Disruption" and "Attrition", which are shown in the table below.
- "Disorientation," which prevents normal decision-making and behavior due to misperception, includes "Dislocation" and aspects used as means of "System Disruption" also exist.



Specific measures and some examples

①	Absorb	Forcing waste of forces and efforts
	Deny reinforce	Difficulty in bringing in follow-on and reinforcement forces (attrition while moving)
	Reverse use of opponent's resources	Adversely use opponent's forces and efforts (self-destruction, refutation of his discourse)
	Change of assumptions	Difficulty in utilizing the expected effects and resources of the other party (bypass)
	Forcing to disposition	Diversion to other fronts (formation of a second front)
②	Misunderstanding	Induce erroneous judgments by creating false perceptions
	Making optimistic	Increased difficulty in grasping unfavorable situations, overconfidence
	Making pessimistic	Increased difficulty in understanding favorable situations and reluctance to act
	Confusing	Difficulty in making decisions due to flood of conflicting information
③	Destructing nodes	Difficulty in organizational actions due to loss of critical functions/capabilities
	Destructing Links	Difficulty in organized actions due to division of forces and information blockage
④		Difficulty in actions due to quantitative reduction in forces and resources

Points

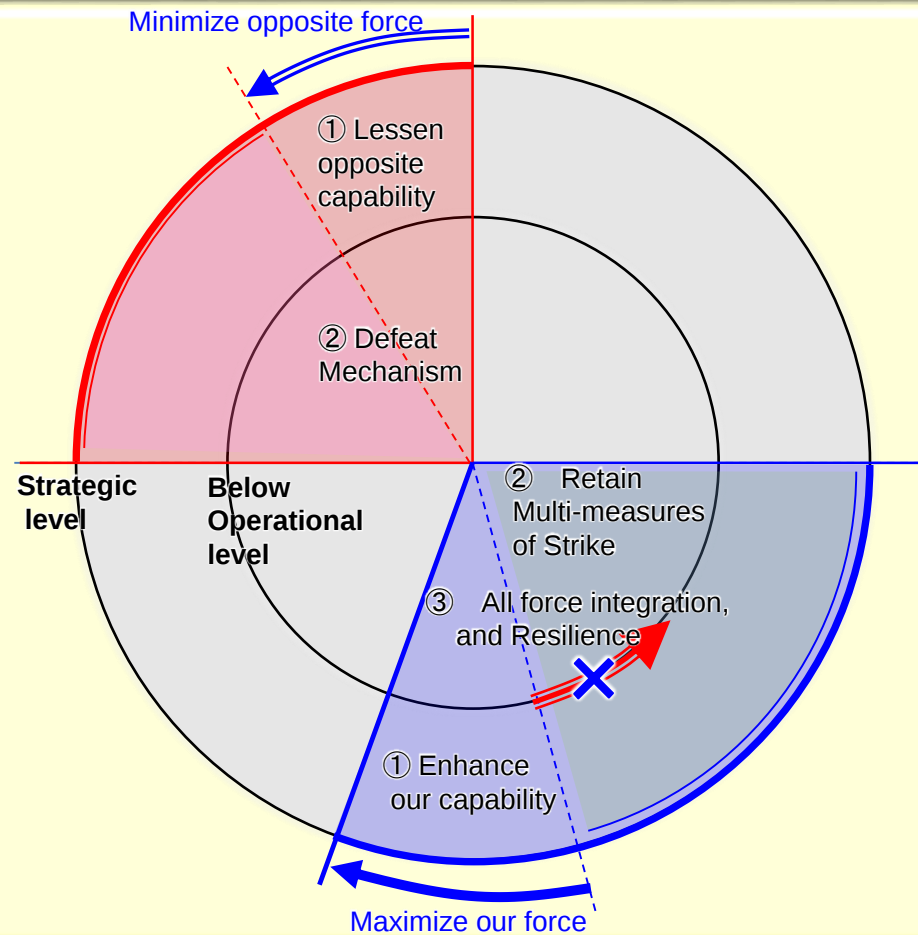
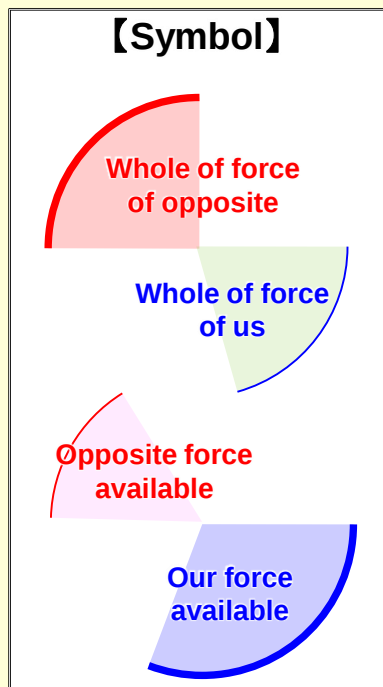
[Basic idea]

Minimize opposite force available and **maximize** our available.

[Points]

- ① Approach to lessen opposite capability at **strategic level**
- ② Retain **Multi-measures of Strike** against transparency of battlefield and quick adaptation.
- ③ **All force integration** in vast area and domains for maximize operational capability & **Resilience**.

Image



1. While cooperating with allies and other ministries ,agencies and private organizations, conducting various types of operations in joint operations and contributing to **shape security environment**.

(Example)

- Strengthening and taking advantage. - Multilateral, Joint, interagency cooperation.

2. **Integrating various forces separated geographically and from other domains to accomplish operations** by longer fire weapons and increased impact on operations in domains such as space and cyber beyond conventional spatial concept.

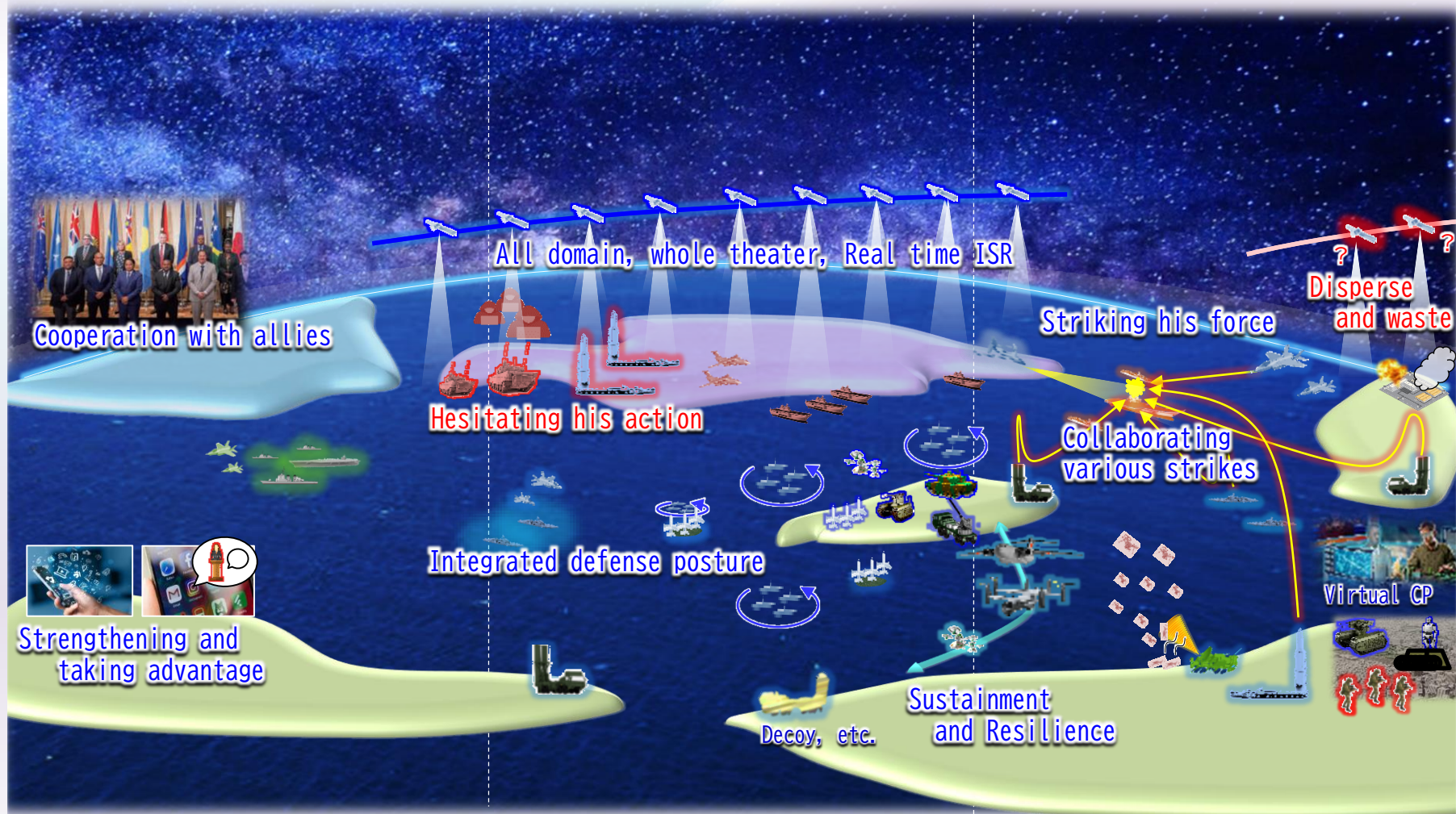
(Example)

- Integrated defense posture. - All domain, whole theater, Real time ISR. - Sustainment and Resilience

3. - In order to deal with obsolescence of weapons and tactics due to visualization of battlefield, machine learning and increased speed of adaptation of military organizations as a whole, **retaining multi-measures of strike** including measures that he can not recognize and imitate and **utilize them collaboratively**.

(Example)

- Disperse and waste opposite power. - Multi-measure of Strike. - Collaborating various strikes



Next Generation Equipment for our Innovation

Summary

Typical examples of equipment to realize ways of fighting around 2040 are following.

C2



Joint C2 system



Next-generation
Communication network



Virtual CP system



Communication SAT

Intelligence



Information gathering SAT



Wide area air
defense radar



Next generation
Reconnaissance UAV



Use of CBRN
judging equipment

Strike



Hypersonic
guided missile



High power Laser

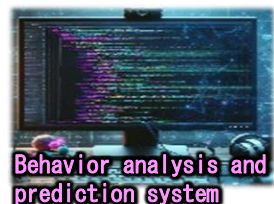
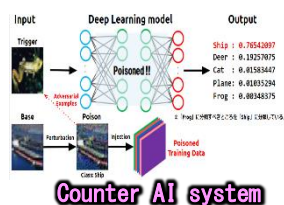


Attack UAV



HPM

Information



Behavior analysis and
prediction system

Unit Movement/Maneuver



High speed hydrofoil

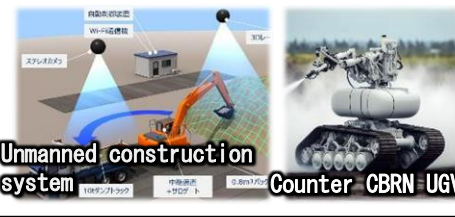


eVTOL

Protection



Active protection system



Unmanned construction
system



Counter CBRN UGV

Sustainment



Parts manufacturing
equipment



Transport UUV



Patient Transport UGV

[Legend] **All Force Integration Multi-measures of Strike** : Relevant equipment for realizing Future Operational Concept

(Originally created by TERCOM based on "Emerging technology (Previous section)", "Future Operational Concept (Previous section)", etc.)

*Introductions of equipment listed above to JGSDF : TBD(now being considered)

Next Generation Technology for our Innovation

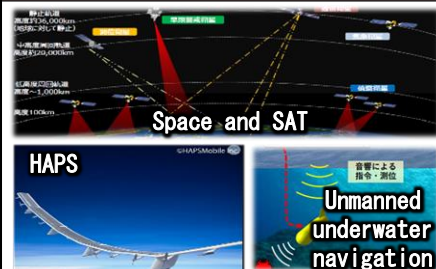
Summary

Typical examples of technology to realize ways of fighting around 2040 are following from the viewpoints of important technological areas(physical , information and cognitive domains) determined in "Defense Technology Guideline 2023".

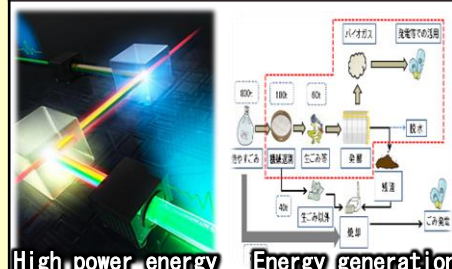
Unmanned/Autonomous



Unused platforms



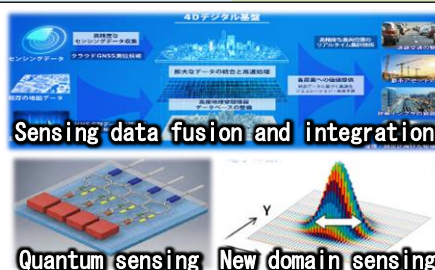
Unused energy



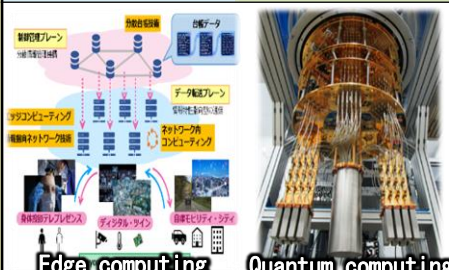
New functional materials



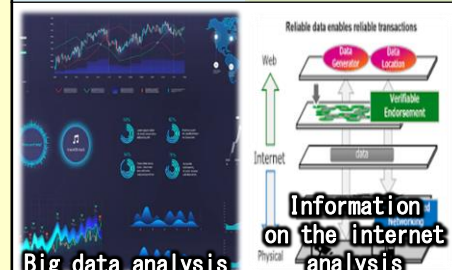
Sensing



Computing



Visualization



Virtual/imaginary info



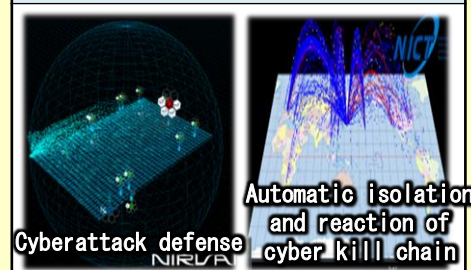
Situation analysis/Forecasting future



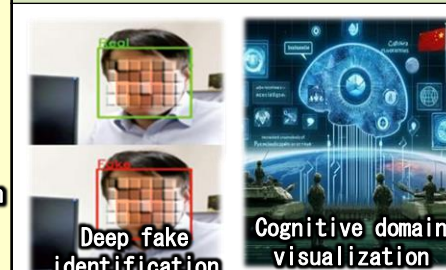
Network



Cyber defense



Cognitive



[Legend] Technology for gaining superiority over each domain

Physical

Information

Cognitive

1 Trends of Global Strategic Environment around 2040(Emerging technology)

- ▷ <https://www.kaku-ichi.co.jp/media/tips/technology/ai-conversion/>
- ▷ <https://newswitch.jp/p/33849>
- ▷ https://www.robonews.net/2014/01/13/nano_drones/
- ▷ <https://nedo-quantum.aist.go.jp/quantum-computer.html>
- ▷ <https://nedo-quantum.aist.go.jp/quantum-computer.html>
- ▷ <https://news.lockheedmartin.com/2022-09-15-Lockheed-Martin-Delivers-Its-Highest-Powered-Laser-to-Date-to-US-Department-of-Defense>
- ▷ <https://assets.publishing.service.gov.uk/media/6286575de90e071f69f22600/FOE.pdf>
- ▷ <https://www.darpa.mil/news-events/2021-09-27>

2 Next Generation Technology for our Innovation

- ▷ <https://www.gao.gov/products/gao23105495>
- ▷ Excerpt from Fujitsu , " Research services regarding possibility of application of human augmentation/enhancement/support technologies(midterm report)Document number : HXR 23 05E FK PRD 1221 001", Dec 21th 2023
- ▷ https://www.rd.ntt/research/JN20200310_h.html
- ▷ <https://www.tamron.com/jp/technology/detail/20230214035250.html>
- ▷ <https://jpsec.ai/attack-to-hijack-ai/>
- ▷ <https://news.satnews.com/2023/05/11/cesiumastros-active-phased-array-technology-is-enlisted-by-raytheon-technologies-for-7-space-vehicles-supporting-sdas-tranche-1-tracking-layer/>
- ▷ <https://www.ga-asi.com/ga-asi-the-future-of-small-uas>
- ▷ <https://www.rtx.com/raytheon/lang/jp/capabilities/products/ghosteye>
- ▷ https://www.army.mil/article/247190/mobile_chemical_laboratory_test_plays_key_role_in_army_modernization
- ▷ <https://www.cbo.gov/publication/58924>
- ▷ <https://news.lockheedmartin.com/2022-09-15-Lockheed-Martin-Delivers-Its-Highest-Powered-Laser-to-Date-to-US-Department-of-Defense>
- ▷ <https://www.sciencefocus.com/future-technology/drone-killer-fires-microwave-beams-to-disable-uavs>
- ▷ <https://www.airforce-technology.com/features/russias-top-long-range-attack-drones/>
- ▷ <https://press.jal.co.jp/ja/release/202310/007663.html>
- ▷ <https://newswitch.jp/p/34247>
- ▷ <https://idstch.com/geopolitics/active-protection-systems-aps-on-military-tanks-detect-track-and-destroy-enemy-rpgs-and-anti-tank-guided-missiles/>
- ▷ <https://www.bing.com/images/create>

Source (image) (2/2)

- ▷ https://jss1.jp/wp/wp-content/uploads/2022/11/shutterstock_1950741178.jpg
 - ▷ <https://www.navalnews.com/naval-news/2022/11/remus-620-hiis-new-medium-class-uuv/>
 - ▷ <https://yab.yomiuri.co.jp/adv/chuo/research/20150205.html>
- 3 Next Generation Technology for our Innovation
- ▷ <https://assets.publishing.service.gov.uk/media/6286575de90e071f69f22600/FOE.pdf>
 - ▷ <https://newswitch.jp/p/21705>
 - ▷ <https://www.nhk.jp/p/gendai/ts/R7Y6NGLJ6G/blog/bl/pkEldmVQ6R/bp/p3O572xIEk/>
 - ▷ https://www.mext.go.jp/content/20200220-mxt_uchukai01-000005509_2.pdf
 - ▷ <https://www.softbank.jp/corp/philosophy/technology/special/ntn-solution/haps/?orig=ja>
 - ▷ https://www.mod.go.jp/atla/research/ats2023/pdf_oral_matl/15_1055.pdf
 - ▷ https://www.riken.jp/press/2023/20231219_2/
 - ▷ <https://www.city.yokohama.lg.jp/kurashi/sumai-kurashi/gomi-recycle/namagomi/namagas.html>
 - ▷ https://www.mod.go.jp/j/policy/defense/technology_guideline/index.html
 - ▷ <https://news.1242.com/article/428490>
 - ▷ https://www.aero.jaxa.jp/topics/magazine/pdf/fp_no23.pdf
 - ▷ https://www.jst.go.jp/stpp/q-leap/sensing/pdf/sensing_pamph2023.pdf
 - ▷ <https://group.ntt.jp/newsrelease/2020/11/12/201112b.html>
 - ▷ https://www.nict.go.jp/nalab/innovative_3.html
 - ▷ https://www.riken.jp/pr/news/2023/20230324_1/
 - ▷ https://www.aist.go.jp/aist_j/press_release/pr2022/pr20220831/pr20220831.html
 - ▷ https://www.ntt.com/business/sdpf/knowledge/archive_63.html
 - ▷ <https://blog.fltech.dev/entry/2023/03/20/verifiable-endorsement-ja>
 - ▷ <https://ucri.nict.go.jp/artl/research/>
 - ▷ <https://www.nict.go.jp/press/2016/10/13-1.html>
 - ▷ https://www.jaxa.jp/projects/sas/mdss/index_j.html
 - ▷ <https://stock.adobe.com/jp/search/images>
 - ▷ <https://www3.nhk.or.jp/news/html/20220425/k10013594101000.html>
 - ▷ <https://b5g-rd.nict.go.jp/special/r05-1.html>
 - ▷ https://www.jaxa.jp/projects/sat/lucas/index_j.html
 - ▷ <https://www.nict.go.jp/press/2021/04/12-1.html>
 - ▷ <https://www.nict.go.jp/press/2024/02/13-1.html>
 - ▷ <https://www.knowbe4.jp/blog/the-shadow-war-cognitive-warfare-and-the-politics-of-disinformation>
 - ▷ <https://www.nii.ac.jp/seeds/2019/echizen-yamagishi.html>