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ISSUE BRIEF

AN INSIGHT: MANNED UNMANNED TRAINING (MUM-T)

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A skillful fighter puts himself into a position,
Which makes the defeat impossible;
And does not miss the moment for defeating the enemy.

- Sun Tzu

Introduction

The past decade stands testimony to the fact, ratifying a period inundated with military dominance built on cutting-edge technology in areas such as surreptitiousness and precision weaponry. With governments meeting at the United Nations in Geneva yet again to discuss Lethal Autonomous Weapons Systems (LAWS) and the 'third revolution in warfare' it seems that highly automated robotic killing machines are closer than ever to going from the realm of science fiction to being deployed in real-world battlefields[i]. The advent of **Manned Unmanned Team (MUM-T)** heralds a period that could reverse the trend of the past quarter of a century, which has seen the deployment of radical and costly — weapons platforms. At a time when the service desperately needs to add combat capacity, while also developing new and enduring advantages in a world of competitive, burgeoning threats, especially when the hostile neighbours are constantly at the doors, this is an opportunity that must be explored and exploited. To achieve this, the Defence Services should explore the advantages that

could be yielded through collaborative teaming of manned and unmanned combat aircraft. This combination may provide increased numbers of affordable aircraft to complement a limited number of exquisite, expensive, but highly potent new generation aircraft.

What is MUM-T?

Future combat operations will require Aviation assets to operate over larger areas of responsibility and project both combat and scout capabilities forward at ever-increasing ranges and speeds. These growing expectations create a pull for maintaining extended data link ranges. Manned-Unmanned Teaming (MUM-T) plays an increasingly significant, mission-critical role for army aviation. It qualifies as a force-multiplier and provides the necessary capabilities to meet the growing challenge of often dangerous operations over larger areas at increasing ranges and speeds. This transformation does not mean simply operating remotely piloted aircraft (RPA) en masse with traditionally piloted airframes—it signifies true autonomous machine-to-machine partnering, where manned-unmanned collectives can operate across a broad front at "machine speed" to overwhelm an adversary's decision-making process.

In one instance, a pilot of a manned aircraft provides an input. If that individual is overloaded with tasks, or has lost linkage, is shot down, or is otherwise unavailable, control could then transfer to an air fighter controller on AWACS, or NETRA, or even a ground control station. If all forms of communication are lost and the unmanned asset cannot execute its assigned mission in a wholly autonomous fashion, it would revert to a failsafe set of instructions

Need for MUM-T

'Failure to make the necessary critical changes, failure to adopt the emerging future, failure to jettison the baggage of the past, failure to accept the realities of momentous changes, individually as professionals and collectively as an air force, will lead to catastrophic failure of the force.' - Sanu Kainikara[ii]

Leveraging the strengths of both manned and unmanned systems significantly improves situational awareness, allowing for greater mission effectiveness and efficiency while simultaneously affording safety and lower risk to operators and assets. Providing pilots of manned aircraft the ability to control UAVs enables them to take full advantage of the intelligence, surveillance and reconnaissance (ISR) capabilities of the UAV, thus enhancing decision-making and improving safety during dull,

dirty and dangerous missions. Some of the apt reasons for considering MUMT as a potent option are given in succeeding paras.

- **High Rate of Accidents**. The recent alarming and upward trend of aircrafts crashing especially in 2019, the facts that precipitate are, frontline pilot requirements have gone unmet, pilot retention issues are rising, combat aircraft in the inventory are wearing out at an accelerated rate and precious well trained pilots are lost overcoming the red tape and bureaucratic hurdles.

- **Rising Threshold of Escalatory Matrix**. The global security environment has accepted the new normal below the threshold of war even post the air strikes which dictates the front line fighter aircrafts to be at the highest state of operational readiness. These altered dynamics portends danger for the any emerging nation, because the effects achieved by bombers and fighters, namely precision strike and air superiority, are essential national security options that policy leaders must consider as a potent response option.

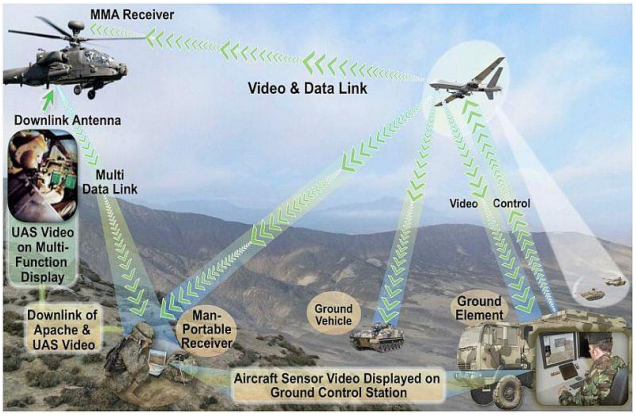
- **Rapidity in Response to Effect & Affect Adversary**. The ability to hit any target on the globe in a matter of hours can yield strategic effects of the highest order—especially when considering alternate delivery methods generally involve days, weeks, or months.

- **Achieving Quantity and Quality**. Sun Tzu said, "**Numerical weakness comes from having to prepare against possible attacks; numerical strength, from compelling an adversary to make the same preparation against us**". MUM-T Concept revolves around Josef Stalin's reported statement that: "Quantity has a quality all of its own."[iii] The quintessence of multiple MUMT platforms operating in cohesion is akin to a Swarm of aircrafts with an important onboard mission leader with human intelligence taking rapid decisions.

- **Airpower Rejuvenated: Turning Old Aircraft Into New Assets**. This radical new technology will allow aerial platform on threshold of obsolescence due to safety concerns primarily because of ageing airframe and engine can be suitably modified by strapping the necessary communication payloads instead of pilot and thus prove as a loyal unmanned wingman to a mission leader flying a cutting edge technology aircraft.

Principle of Operation

The MUMT essentially is a pioneering marvel where in the on board state of art communication systems implanted in modern aircrafts are employed to create a “Communication Package” among the group of aircrafts aloft using robust algorithms. Post the establishment of fail-safe communication, the mission leader will have an option to operate / handle payloads of other aircraft using tools available in his cockpit. Also, the seamless interconnectivity will ensure robust feedback in terms of telemetry and/or real time video footage based on levels of interoperability. This is made possible with the advent of Distributed Systems.



Distributed Systems: Human IN the Loop v/s Human ON the Loop

“In the future, pilots may be acting more like mission commanders for a distributed force, with their actual aircraft doing much of its flying in an automated fashion.”

- ***Kris Kearns, Air Force Research Laboratory***

The highly distributed control pioneered by the modern UAVs strongly suggests that manned-unmanned partnerships could be augmented with multiple layers of real-time human support. The notion of distributed control touches upon two different operating approaches—the “human in the loop” and the “human on the loop.” The former, which the traditional UAVs employ, involves an unmanned aircraft proactively flown with the mission crew carefully monitoring and commanding systems to control desired outcomes. The UAV effectively functions like a remotely controlled airplane at extreme distances. The latter approach, which directs UAV mission systems, uses automated technology to execute mission functions with minimal human interaction. The aircraft functions more like a satellite, with operators making occasional inputs, as opposed to a traditional aircraft requiring hands-on guidance. This impressive capability is an inbuilt feature in modern UAVs like Heron where mission parameters offer

auto-land and take off (ATOL) functions with minimal human intervention **post the decision** to carry out autonomous functions by the pilot.

Level of Interoperability[iv]

The concept of interoperability is exceptionally crucial in MUM-T. Broadly speaking, interoperability is the ability of different systems to communicate, exchange data and use the information that has been exchanged; in this case, the systems would refer to the pair of manned and unmanned platforms. The Level of Interoperability (LOI), as defined by NATO Standardization Agreement 4586 (STANAG 4586), describes the control that a user has over the UAV, the payload or both. There are five different levels, with Level 5 requiring the installation of a fully Remote Pilot Station (RPS) in the manned aerial platform and providing the crew with maximum control:

- Level 1 - Pilot receives data from payload indirectly, i.e. through a third party.
- Level 2 - Pilot is in direct communication with the UAV and receives data from its Payload.
- Level 3 - Control and monitoring of the UAV payload, but not the aircraft
- Level 4 - Control and monitoring of the UAV, without launch and recovery
- Level 5 - Control and monitoring of the UAV, including launch and recovery

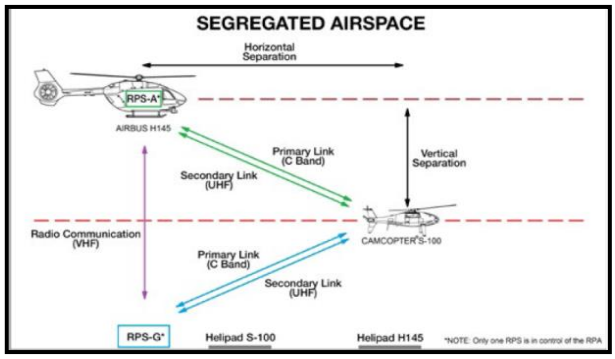
Implementation of MUMT in Global Arena

"When I think about manned-unmanned teaming, I need to believe that the autonomous aircraft will behave in a safe, predictable fashion. My overriding concerns center upon basic flight behavior — maintaining position in a formation, not colliding with me or other assets, letting me knows when an unmanned partner has a problem, and dependably reverting to failsafe settings in times of trouble".

- ***Col Ray O'Mara, USAF***

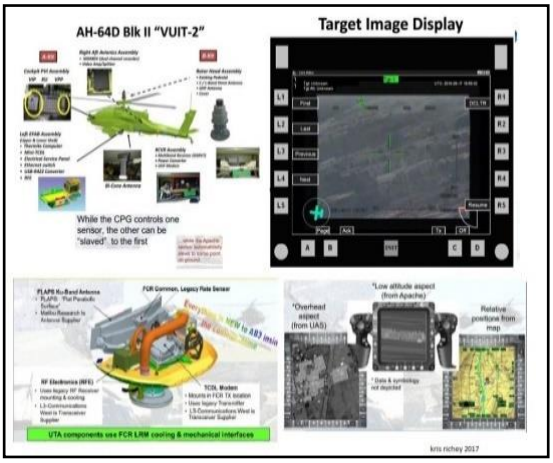
Numerous technical advancements are being made evolving smarter autonomy and enhancing the speed of decision. The machine learning is coming up in a big way where in computers have started self-learning in an exponential manner. Lot of money is being pumped in R&D to get leaner and meaner machines. Some of the incidents in the global arena are enumerated below:

- **<u>Airbus & Schiebel</u>**[v]. Airbus Helicopters and Schiebel have tested Manned Unmanned Teaming (MUM-T) capabilities between an H145 platform and a CAMCOPTER® S-100 Unmanned Air System (UAS), thus becoming the first European helicopter manufacturers to demonstrate this technology with the highest level of interoperability (LOI – 5).



- **<u>Arrival of Triton in the Pacific</u>**[vi]. The U.S. Navy's recently deployed the state of art Triton UAV at Guam to classify and identify vessels on the ocean or in the littorals in some of the world's busiest shipping lanes. Triton's ability to fly at high altitude and remain airborne in excess of 24 hours facilitates commanders to surveil a larger maritime area than ever before. Designed to operate in a manned-unmanned teaming concept, Triton provides an unblinking eye over massive swaths of ocean and littoral areas, enabling manned aircraft such as the U.S. Navy's P-8 Poseidon to focus on anti-surface and anti-sub-surface warfare.

- **<u>Loyal Wingman: XQ-58A Valkyrie</u>**[vii]. The Kratos-built Valkyrie is a platform for Air Force experiments with the Skyborg "loyal wingman" technology, an Air Force spokesman explained. The Skyborg "brain" is envisioned as enabling a fleet of low-cost drones to accompany F-15 EX and F-35 fighter jets in the future. Both efforts are part of the Low Cost Attritable Aircraft Technology.



- **<u>Apache & MQ-1C Gray Eagle : MUMT-X</u>**[viii]. A built-in air-to-air-to-ground relay in MUMT-X, is based on the Rover data link, which allows Apaches to send video feeds and telemetry from MQ -1 C straight to personnel on the ground or ships below, as well apart from getting the same in its cockpit. The Army demonstrated the ability of an existing AH-64E, together with an MQ-1C Grey Eagle unmanned aircraft, to provide stand-off targeting support to artillery units ashore and a communications relay for ships at sea during the Rim of the Pacific (RIMPAC) 2018 exercise.

- **<u>S-70 Okhotnik-B</u>**.[ix] Russia's S-70 Okhotnik-B, or Hunter-B, was flown together with a Su-57 advanced combat jet to demonstrate MUMT capabilities developed by the Russians. This translates into S-70's

future missions being to operate together with the Su-57 in a "loyal wingman" role, which could help mitigate some of the shortcomings of the latter manned aircraft's design and usher in new air combat synergies overall.

- **E-18 Growlers**.[x] Boeing and the U.S. Navy successfully linked manned and unmanned growlers in a test. The U.S. Navy flew two Boeing EA-18G Growlers as autonomous unmanned air systems, using a third manned Growler as their mission controller.

- **Exercise 'MUSIC'**.[xi] The first ever Exercise on Manned-Unmanned Systems Integration Capability, or MUSIC was the largest demonstration of manned-unmanned interoperability ever attempted. The event established seamless integration of Apache Block II and Kiowa Warrior helicopters, along with the Army's complete fleet of Unmanned Aircraft Systems, which is comprised of the Raven, Puma, Hunter, Shadow and Gray Eagle. Video was exchanged flawlessly among all the systems. Additionally, the ability to control the UAS payloads of the larger aircraft from both the Ground Control Stations and the Remote Video Terminal were demonstrated.

Chinese Perspective on MUMT

China has a substantial MUMT muscle[xii]. As with the other Chinese program and projects of sensitive nature, the innovative MUMT capability has largely remained obscured from the public eye. Full technical prowess of its machines is really not known to the extent desired. As stated, most of it is assessed / inferred. It is only obvious to infer that MUMT will be very much a practiced concept with China, as will be the autonomous attacks using UAS and swarm attacks. Based on a recent article[xiii] some of the inferences drawn from the Chinese Perspective of MUMT implementation and Employment indicate the concept of having a '**Loyal Wingman**' or an '**Autonomous Buddy**', with substantial Artificial Intelligence (AI) embedded for taking on high risk missions. The same is described below:

- **Serve as "Eyes and Ears" to Facilitate Enhanced Situational Awareness**. In the implementation of beyond visual range (BVR) operations, the traditional task of target detection and target acquisition will be delegated to the Loyal Wingman from where, real time information will be transmitted to be to the manned machine. The unmanned wingman will be equipped with a reconnaissance payload and necessary communication system, which takes the lead to go in to the depth of battle-field or far behind

enemy lines. The manned aircraft will be deployed at a relatively safe distance and operate the UAVs to perform tasks which include optical detection and acquisition of targets apart from detection of active radiation targets.

- **Act as "Fangs" and Cooperate in Air Combat**. In a complex confrontation environment, a manned aircraft will take on simultaneous command of multiple UAVs to conduct coordinated air superiority operations and jointly attack air targets. The traditional tactical coordination pattern between the lead plane and the wingman will evolve into the lead plane commanding the wingman remotely and waiting for opportunities to supplement the strike pattern. Manned aircraft can be loaded with autonomous modules compatible with different types of UAVs, providing pilots with AI-assisted decision-making, intelligent mission planning and interactive interface support, sharing task pressures, allowing pilots to focus on decision-making, and fighter aircraft focus on execution. The drone keeps its radar silent, stealthily approaching the enemy at high speed like a ghost. When it reaches the range of its weapons, the manned aircraft turns on the radar to detect the target, transmits the target information to the drone in real time through the data link network, and directs the drone to strike.

- **Take on the Role of "Fist and Foot" & Coordinate Air-to-Surface Strikes**. When performing strikes on the ground or sea or close fire support missions, manned aircraft are often tied for safety reasons. With drones acting as "pawns", the combat radius of the aircraft can be expanded under the premise of protecting the safety of manned platforms. Manned aircraft can use the intelligent unmanned wingman as a weapon expansion module to control the drone outside the enemy's threat range. UAVs can carry guided munitions and carry out tasks such as powerful assaults, wave interception, cluster air domination, or lure the enemy to open fire, which virtually increases the range of long-range airborne guided weapons.

- **Act as "Bait" for SEAD Operations**. By carrying special electronic equipment to simulate the radar reflection characteristics of a fighter jet, the UAV can cause the enemy's warning radar to misjudge and induce its air defense radar to turn on, thereby exposing the radar frequency and position, and providing target parameters for subsequent anti-radiation strikes for a manned or an unmanned aircraft. This tactic may also be employed to confuse the enemy's air defense firepower through early feint attacks, so that the firepower is consumed in intercepting, searching, identifying, and

tracking these false targets, thereby opening up firepower gaps for subsequent fighters to carry out effective assaults.

Applications in Military Environment

The state of art technology can be employed in multitude of domains and sky is the limit of application. Though, the technology is still in its nascent stage of development, the applications that are being brain-stormed have been amazing and scintillating, in terms of exploring possibilities of enhanced surveillance, protection and distributed computing. Some of the applications that have been thought about are mentioned below:

- **Intelligence Gathering.** In a congested tactical battle area, teams of tiny quad copters could sweep around to gather intelligence in a short tactical time frame.

- **Swarm Attack / Saturation Attack**. Tank concentrations could be swamped by multiple aerial platforms firing or diving autonomously. The so called "**Kamikaze**" Drones could also cooperate in a 'saturation attack' on an enemy missile launcher. They all dive in to attack simultaneously from different directions – far too many at once for the defenders to stop.

- **SEAD Capability**. Air defense generally with a limited supply of missiles can be overwhelmed by enough opponents as unmanned members in MUMT are expendable in nature, meaning, few being downed by enemy AD will not alter mission parameters.

- **First Wave of Attack**. These might be the first wave to hit the beach ahead of the humans, scouting, locating enemy positions, and possibly attacking them.

- **Unmanned Wingman**. This technology can assist a mission leader to employ unmanned combat aircrafts for dull and dangerous missions without entering the harm's way.

- **Air to Air Refueling Operations**. MUMT can be a unique method for exploring this procedure which can allow extending the strategic reach of the manned aircrafts.

Advantages of MUM-T Technology

The advent of this state of art of technology has given rise to numerous possibilities of integrating the UAVs/ Drones with the Manned Platforms. Though not exhaustive, some of the advantages that can accrue with this equipment are brought out below:

- **Reduce the Human Risk**. Protection expensive manned helicopters and their crews while exploring dangerous environments

- **Enhanced ISR Capability**. Opportunity to enhance the ISR capability of manned platforms especially in complex operations. Ability of manned helicopters to explore larger areas by increasing ISR coverage from single manned platform.

- **Nape of Earth of Flying with Enhanced Situational Awareness**. Flying, terrain-screening manned helicopters with a top-down view from UAV operating up high where its signature is low enables better situational awareness and less exposure of manned platforms to enemy's fire and observation.

- **Down Sizing Forces**. Nations, worldwide have patronized downsizing their militaries, prune up budgets and reduce teeth to tail ratio. MUMT would require far fewer active troops and reduced administrative and technical support.

- **Adaptable to Multiple Losses**. One missile can bring down an aircraft, but multiple unmanned aerial platforms can overcome a couple of them being shot down however mission can continue.

- **Mitigate Conflict Escalation**. MUMT technology is attractive to modern militaries as it would allow them to project force with a lower probability of military confrontation. Drones, unlike fighter jets or aircraft carriers, are less threatening and can be shot down or captured without triggering a military escalation since risks associated vis a vis manned systems are far too low.

- **Friendly Economics**. The technology invovles less complex manufacturing processes can be achieved by using planes nearing obsolescence and cheaper UAVs.

- **Human Resource Management**. The training and maintaining the crew currency and the associated tasks for conventional UAV operations are a huge impediment on routine basis and thus pose a constant challenge in terms of crew management. Additional expenditure incurs on training infrastructure which cost the exchequer a huge sum which could be mitigated with use of MUMT Technology. MUMT technology being highly autonomous involves greater level of abstraction for the user and would require far few operators, thereby reducing costs in all aspects.

Challenges in Implementation

There have numerous challenges that have been encountered towards achieving this feat. Though, the pivotal issue in this regard continues to be the critical and delicate Data Link requirements, certain additional points have also been covered below:

- **Memory and Resource Allocation**. Since this system runs in real-time, the guidance system must make provisions for a safe and achievable solution in a pre-defined period of time using the hardware provided.

- **Communication and Bandwidth Issues**. The Link-16 communications system sends information every second. As a result, there was an upper limit to the amount of user information that can be transmitted at every iteration. Therefore, the user information transmitted between both aircraft must be concise and include the necessary information required for both vehicles (and their operators) to make decisions.

- **Robustness Issues**. Because the environment was not controlled and only partially known, the systems designed for each aircraft had to be robust to external and unexpected conditions. For

example, if information between vehicles is not received, either vehicle should re-transmit its data. Likewise, the guidance system must plan paths that are robust to environmental conditions (i.e. pop-up obstacles, no fly zones, changes to the mission plan, wind conditions).

- **Software Integration Issues**. Since each software module for the demonstration was in development at the same time, modifications to any system component could have major effects on the development of the others.

- **Air Space Management**. A major challenge which is concurrent to application of MUMT technology is to formulate policies and lay down SOPs to entail safe and optimal utilization of air space which has multiple consumers, especially in TBA.

- **Human Resource & Training**. There is pressing need for trained operators and programmers who can understand mission imperatives in-situ and carry out robust changes and operators to concurrently adapt to fluid situations to carry out successful operations.

MUMT Developments in India : Combat Air Teaming System (CATS)

'We must constantly search for new ways of fighting, and not merely using new weapons to fight in the old ways.'

- ***Phil Meilinger***[xiv]

CATS[xv] is led by HAL in collaboration with a Bengaluru-based start-up, Newspace Research & Technologies. It will involve a recoverable wingman within a combat radius of 350km. The range would increase to 800km for a kamikaze attack on target. The proposal is to have CATS Warrior (CW), CATS Hunter (CH), CATS-Air Launched Flexible Asset (ALFA) and CATS Infinity (CI).

CW autonomous wingman drone would be capable of take-off and landing from land and aircraft carrier. It will team up with the existing fighter platforms of the IAF such as Tejas, Su-30 MKI and Jaguar which will act like its mother ship. The CW will mostly serve as a 'sensor amplifier' for the LCA, flying out ahead of the manned aircraft and using its sensors to feed information back to the LCA. The CW would be equipped with suitable ISR/EW payloads and will internally mount air-to-air missiles

or air-to-ground weapons. The CW itself could launch up to 24 ALFA-S swarm drones.

ALFA is a system which carries four swarm drones inside its container. It can be launched from a combat aircraft. The container has a range of about 100km after launch from the aircraft. ALFA-S has five to eight kilogram warheads and can fly under its own propulsion and perform autonomous ground-target acquisition and attack. Both the SU-30 MKI and the Jaguar aircraft will be capable of carrying the ALFA-S.

CATS Infinity (CI) drone is to operate at a predetermined position at extremely high altitudes (65,000ft). It would use of self-generating power (solar panels) so as to remain aloft for extended periods of time of up to three months. It will provide enhanced real-time ISR inputs for deep-strike aerial missions.

Relevance of Development Unmanned Technologies in Indian Context

Owing to the budgetary constraints on the part of defense procurements and the fiscal health of our nation, it may be not be realized now, but in times to come, such erudite systems need to be amalgamated in our arsenal, especially in a state where the neighbours, are not silent and relentlessly knock the doors. Many cognoscente may opine, orthodox warfare has lost its relevance and it may prove to be true but that should not deter our nation to compromise by any means in matters concerning latest advents in defence technology. However, the recent Russo-Ukraine war has put to rest the inhibitions held by many on the likelihood of kinetic conflict.

Conclusion

Rapid leaps in UAV technology have led to the creation of a much-needed refuge in the escalatory matrix below that of open conflict. Not only has the platform demonstrated its capabilities of meeting difficult military aims, it has also consistently shifted the onus of the escalation of the targeted side. However, the advantages of any new technology can be reaped only before its mass proliferation. The era of heavy tanks and area pulverization is slowly and surely ending, and precision platforms like UAVs are fast emerging as the new weapons. However, being an aspiring regional power, it is incumbent on us not only to acquire the technology, but also the advance it with indigenous Research and development to turn the tables in our favour.

CERTIFICATE

The paper is author's individual scholastic articulation. The author certifies that the article is original in content, unpublished and it has not been submitted for publication/ web upload elsewhere and that the facts and figures quoted are duly referenced, as needed and are believed to be correct.

Disclaimer: Views expressed are of the author and do not necessarily reflect the views of CENJOWS.

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