Master Current Limitations

TEAM	Current Limitations	Ways to Overcome	
RED	Information sharing & understanding scope of what/who's out there	More silent swarm like events (Navy)	
RED	Communicating classified information in a non-class way	More silent swarm like events	
RED	Industry access to clearances	More silent swarm like events	
RED	Who/where/etc are they testing	More silent swarm like events	
RED	Priorities of spectrum	Modularity and flexibility	
RED	Selective observation/detection (friendly vs adversarial)	w	
RED	When / to what extent to employ standards	Government has to assume cost for non-standard things (e.g., batteries, interfaces, flight testing quals, data format)	
RED	Disparate CONOPs across services	GCC defined	TK
RED	Commercial solutions =/= innovative	Government needs to cover the R&D	
RED	High variety of consumables or inputs from COTS solutions/components	Develop selection criteria	
RED	What is attritable? (Left in place, useful life, adversarial recovery, cost)	Standardization	
RED	User buy-in (not just PM or GO exuberance)	Access to the Warfighters in the development phase	
RED	Masking active communication		
RED	Power & connectivity		RM
RED	Trust in information delivery / comms (redundancy, security)	Analytics layer + leveraging sensors against one another	
RED	USG focus and funding & PoR/Prime IRAD (timelines, amount)		
RED	data exfiltration		
RED	cost of prototyping, US manufacturing, supplychain standup	Government buy in; define what makes sense to invest in	
RED	supplychain lead-time	Government buy in; define what makes sense to invest in	
RED	business model justification	Government buy in; define what makes sense to invest in	
RED	synchronization of multiple businesses for each part	Silent swarn like events / consortium	
RED	balancing tech and maneuvering		
RED	selectivity of cheap sensors	Improve manufacturing processess	
RED	# of things to detect vs size/cost		
RED	logistics of sensor configuration forward		
RED	sensor accuracy probability management/analytics for an entire network of sensors		
ORANGE	No fielded Low-cost chem agent detector (JCAD is POR)	- ST new development, shop the shelves of JPEO/DTRA/existing tech, FRP contract to lower the cost. LOW COST is the issue here. Making the detection tech GFE.	
ORANGE	Funding for low-cost chem detectors hasn't been there	See above. Joint alignment is necessary. Informed requirements document, backed by tangible metrics, well-communcated intel on a chemical threat.	
ORANGE	No vendors expert in the full architecture (detection, reporting, Comms, power, packaging,) produce low-cost solutions	Demonstrate a federal (not just DoW) need to provide customer scale. Demonstrate that funding will follow interest. (Prize challenge)	
ORANGE	Gov't market is not largest enough scale to enable truly low cost/unit business models (Particular problem in CBRN sensing)	Increase customer base Make it 'dual'-useable, (DoW; Federa/Civilian; Allies) Deliberate hazard detection Scope	TW
ORANGE	Loss of div and below CBRN recce elements - no replacement capability yet	*reassess unit organiation / validate current decisions (Risk/Reward) *Develop technological alternatives that sense and report chemical threats in the battlespace	
ORANGE	Current sensor sensitivity and specificity is not sufficient for SOF forces	*Determine Objective/Threshold for user community - informed by the operational need *Desired capability is a BOOLEAN value; impacts density and coverage CONEMP *Software defined Sensors *Software flexible system to use various systems	
ORANGE	No common architecture to employ a chem micro sensor solution	* Make a standardized package with modular sensor/capability suites.	
ORANGE	Current sensing tech/solutions has not yet been packaged for the employment environments	*More clear environmental requirements, better unclassified description of its use.	
ORANGE	Current deployment solutions highlight friendly force positions and actions	*EMI is big concern, go sub-GHz. Also if its a confirm/deny mission, security isn't a huge concern. Or just dump a ton of them.	
ORANGE	DoW is not organizing itself well to clearly define and articulate this problem set	*Michael says they are.	
ORANGE	Current sensors are static in their detection mechanisms, while the threats may b	* Make them cheap, blanket multiple and/or large areas	
ORANGE	GPS denial currently undermines sensor position data	*Only need its location once. Quantum EM sensing (expensive though).	
ORANGE	Current sensors are generally single modal and packaging is built to purpose, rather than common hardware architecture	See above answers	
ORANGE	Current chem sensors may require decon/reset after initial detection (no enduring	See above answers	
ORANGE	No intelligent backend data fusion/analysis capability to reconcile and understand	N/A	TK, RM
ORANGE	No sensing capability on the individual soldier	N/A	

ORANGE	High false positive rates on current sensor		
ORANGE			
ORANGE	Comms issues	If we can do burst comms (only if detected) that can extend lifetime. Send out a small data burst packet to an LEO satellite. Keeps power req low. Iridium/starlink.	
ORANGE	Power issues	Give us an ICD that we can work from to know how much power is necessary. On 1 JULY, army is planning to release something like this.	
YELLOW	real time signaling (congested communication to Cmd Ctrl)	Common semantics + edge AI for on-site inference and efficient transmission of decision	
YELLOW	use existing dispensing system - e.g., make sensor same size as M2O3 grenade to use grenade launcher they already have		
YELLOW	thermo stable biological sensing reagents	lyophilization (freeze dried) storage / onboard liquid handling / future looking synbio sensors	
YELLOW	time to sense bio - how close to real time is possible?	targeted assay (5 min)	
YELLOW	specificity - detection or identification?	tuned to detection requirement / who's mission; compromise "ID" resolution	
YELLOW	pharmaceutical based agents - fentanyl (in solid phase - low vapor pressure / airb	Active air sampling / filtration	
YELLOW	classical vs new chemical agents (PVAs)	Away from specific molecular ID, toward a "class-based" or "effect-based" detection; situational awareness of data analysis (ongoing R&D)	TW, HK
YELLOW	chemical and biological detection on the same device	only combine when (it makes sense); effect-based detection versus analyte I.D.	
YELLOW	minimize electronic signature	Common semantics + edge AI for on-site inference and efficient transmission of decision	
YELLOW	sensors as a network rather than individual sensor - data analysis to account for network of sensors, what to do when there is discrepancy	Common semantics + edge AI for on-site inference and efficient transmission of decision	
YELLOW	Standardization and coordination between agencies	data standards / common semntics / COTS network management	
YELLOW	No infrustructure to do SW and HW testing together	establish / partner , USG labs,	
YELLOW	Have not yet tested neworking with a centralized node (for chem/bio)		
YELLOW	Supply chain issues	leverage emerging coalition suppliers; build awareness of US based manufacturing	
YELLOW	Data and metadata standardization	"YANG" - metadata s/ semantics standard DoW efforts	
YELLOW	MIL standard tradeoff vs. cost	Off the shelf network management	
GREEN	Security of comms network	encryption chip, silence/burst preprogramming	
GREEN	Emplacement difficulty		
GREEN	IR signature	mimic environment	
GREEN	Jamming resilience & spoofing detection		
GREEN	Sensor reusability	low cost disposable sensor, prepare for a single use sensor	
GREEN	Solar power quirks	panels need to be configured for specific voltage needs	
GREEN	Size	monolithic integration of sensor with control electronic	
GREEN	Weight	monolithic integration of sensor with control electronic	
GREEN	Power	monolithic integration of sensor with control electronic	
GREEN	Cost	monolithic integration of sensor with control electronic	
GREEN	Modularity & standardization	suite of sensors,	PG
GREEN	Battery safety	adaptiing already established MIL standards	
GREEN	Sustainment & logistics		
GREEN	Environmental impacts (leave devices; basic debree/litter)	Assume ERDC will fix it later.	
GREEN	Recollection & reuse		
GREEN	PNT reacquisition		
GREEN	Data transmission / bandwith		
GREEN	Compliance (ATO, FIPS, etc.)		
GREEN	OPFOR Exploitation of Hazard Warning for terrain shaping		
GREEN	Data Ingest architecture		
GREEN	Integration with existing (which) infrastructure		
GREEN	Report aggregation deconfliction		
GREEN	OPFOR leveraging exsting, surpassed sensor, to sense Friendly assets		
GREEN	All weather/all terrain objective may drive cost		
GREEN	Littoral sensing - emplaement and sustainment challenge		
GREEN	OPFOR repurpose of materiel (Direct, or re-implementation of tech)		
GREEN	Signal supression/strength/air-space-conflict		
GREEN	Necessity of tracking stored and emplaced sensors		
GREEN	Storage requirements for sensor equipment (too hot/cold/humid)		
GREEN	Industrial base production rate (able to mass produce a low cost attritable system)	Is the market there for mass production? Oil and gas, health markets for similar tech? Investment from Army? Is there a definable path to go from military to cusumer industry?	
GREEN	Environmental impacts (Toxicity of testing materiel)		

GREEN	Supply chain challenge for ASICS		
GREEN	Schedule to transition from small production to mass production	identify govenment approved vendor, NDAA compliance or figure out how to disrupt Chinese technology, or build trusted foundaries for smaller chips.	
GREEN	CONUS distribution federal laws? challenges	Does it contain hazmat?	
GREEN	Forward supply chain to resupply attritable systms		TK, PT, TA
GREEN	Shelf Life considerations (Warehouse, Conus, OCONUS)	What is the technology. Less fidelity may be ok with longer shelf life.	
GREEN	DeMIL considerations	self destruction? anti tamper so they can back engineer	
GREEN	Positioning of sensors in a GPS denied Environment	pre-planning location of emplacement, subterranian. know within 1-5% error, amke it trackable with a low fly drone etc.	
GREEN	Dispensing of the sensors in a manner where granularity is useful	modelling and simulation, know the radius of influence	
GREEN	Clear indication of threat to be detected	redundancy	
GREEN	Offensive vs Defensive priority/balancing	make a noise machine	
GREEN	Network health indication. Bad RF or faulty hardware?	combination of sensors for specific environmental needs, including EW effects, know areas of limited information, redundancy.	
GREEN	Wireless mesh topography and battery management	self healing	
GREEN	Environment of operation	know your limitations and use appropriate tech., modularity - different com systems matched to different components	
GREEN	Sensor deployment methods	NON CONCUR.	
GREEN	Development cycles fast enough to counter the counter action.		
GREEN	Computational limitations.	focus the device to a limited set of analytes, use RP2350	
GREEN	Encryption		
GREEN	Acceptable level of false positives	Need specification from operations	
GREEN	Unobtanium	obtainium	
GREEN	Sensitivity		
GREEN	Enemy Deception Detection	anti tampering and encryption,	
BLUE	Not able to identify CBRN threats remotely	Develop new sensors or emplacement methods; some things (radioactivity) can be detected already; scale sensors and make them disposable/ easily deployable	
BLUE	Strong ID, weak on sensitivity for some threats	The more sensors, means of sensing, and inferencing that is forward the better the sensitivity. Eg. combine spectral and chemical sensing to detect chemical weapon and reduce fasle positives.	
BLUE	Tradeoffs between sensitivity, range, cost	Lots of sensors are available COTS. Need to assess and integrate those sensors. Need to define requirements for a set of conditions that is flexible enough to make room for many sensors and CONOPS. Give industry example battlefield scenarios. Add maneuverability to the sensor network to reduce cost/range issues.	TW
BLUE	Getting information back to someone who can use it	Use systems that move through the area (UAS, others) to collect data as they pass by. Develop low-signature mesh networks for comms. Process as much data at the edge as possible to limit comms bandwidth needs.	TA, RM
BLUE	Transmitting data without revealing position	Use systems that move through the area (UAS, others) to collect data as they pass by. Develop low-signature mesh networks for comms. Process as much data at the edge as possible to limit comms bandwidth needs.	
BLUE	Current infrastructure (comms)	Have a common comms method (formats, frequencies, etc.). Make sensors smart enough to know when to do on-demand comms (e.g. chem sensor uses up battery to send signal/ beacon of chem round detected and then dies).	
BLUE	Noisy environment to sense in	Improve classifiers (both sensors and inferencing from the data); test sensors in representative environments.	
BLUE	Size of sensors	Often limited by batteries/ power supply. Improve battery or energy transfer or reduce power requirements. Miniturize sensor surface.	
BLUE	Current military tactics/techniques/procedures - needs to be used across formations (not only by CBRN soldiers)	Support flexible maneuver. Army needs to work out new TTPs.	TK
BLUE	Need to know emplacement method to optimize	Involve industry in emplacement method standardization.	
BLUE	Terrain effects the mesh network for comms/ distribution	Quantify terrain effects and come up with SOPs for different terrain types. Optimize signal to noise. Develop transmission methods to detect signals below noise floor.	
BLUE	Need to be inexpensive	Supply chain maturity. Forcastable production amounts and need. Define inexpensive and attritable.	
BLUE	Must be able to deploy at volume	Supply chain maturity. Forcastable production amounts and need. Define number of sensors needed. Optimize emplacement methods to deliver many sensors at once.	
BLUE	Need redundancy	Optimize mesh (standard comms protocols) to allow some sensors to be missing from the network.	
BLUE	Positioning (without spoofing)		
BLUE	Availability of complementary assets (delivery, comms, etc.)		
BLUE	System integration		

BLUE	Biology sensing - ID is hard	More R&D to make classifiers for biology. Flag changes from normal rather than providing ID at first.	
BLUE	Biology sensing - power requirement is high	More R&D to make classifiers for biology. Tailor power to particular requirement.	
BLUE	Operator training - how should soldiers react to the infromation?	Make the interface very easy to use, clear outputs. Make as intuitive as possible for soldiers without added training. Have a robust interface that doesn't easily fail with bad input.	TK, HKS
BLUE	Supply chain issues for advanced materials for sensing		
BLUE	Power to Size ratio of device	Define how much endurance the platform needs.	
BLUE	Gov Regulations on Power & Battery Devices		
BLUE	Barrier to entry for small businesses due to investment requirements.		
BLUE	Sensor Reconfiguration Req		
BLUE	DDIL (Denied, Distrupted, Intermediate, & Limited)		
BLUE	Spoofing of specific sensing modality	Quality control of data to check that it is what you expect. Encrypt data. Anti-tamper safe guards. Redundant sensors to check for something that appears out of norm.	TA, MP
BLUE	Tamper Prevention & Detection	Quality control of data to check that it is what you expect. Encrypt data. Anti-tamper safe guards. Redundant sensors to check for something that appears out of norm.	MP
PURPLE	access to data (use cases)	declassify data or make data availability//	
PURPLE	collecting data from sensors (size limitations)	data prioritizatoin and filtering, time relevancy of information	
PURPLE	Data backhaul	develop SOPS for different environments and prioiritzze data // leverage commercial comms platforr	PT, TW
PURPLE	supply chain (us market $$$)	NDAA exceptions to policy // allow for dual use technology to reduce costs// point of need manufcaturing	
PURPLE	Understanding exactly what the need is	werer doing it live	
PURPLE	Cost for power and comms	leverage COTS/ mass prduced commercial products	TW
PURPLE	Industry partnerships (OEM to OEM)	contract structures and teaming agreements	
PURPLE	Industry prototype vice DoW (contraints on equipment producers)		
PURPLE	Data exfil in DDIL or contested environment	line of site optical, cabled fiber, spectral analysis and frequencey agility (resilient comms architecture)	
PURPLE	Data processing	small forma factor, low power specilaized chips + layered approach	
PURPLE	DoW relying on companies to use IRAD, small business have trouble	SBIR funding at phase 1 level, tolerance for lower TRL offerings	
PURPLE	**Standardization (MOSA)**		
PURPLE	Emplacement		
PURPLE	Data standardization		
PURPLE	communication from stkeholders // gov// FAR regulations		
PURPLE	whole of goverfnment comms// awareness (SILOS) cross services		
PURPLE	access to real time threat information		
PURPLE	Concepts of operation for theater/ environments/		
PURPLE	definition of attritable		
PURPLE	lack of edge compute		
PURPLE	scale up funding		
PURPLE	sharing IP		
PURPLE	prioirty shift		
PURPLE	cycle time biz vs gov		
WHITE	Requirment (size, backhaul, weight, pwr, enviorment)	understanding end user needs / communication	
WHITE	Funding / Cost / POAM Delivery Timeline	More RDT&E	
WHITE	Distance	sensor network density, UAS flyover, terrain optimized placement	
WHITE	MOSA (Modular Open System Approach)	defining standards	
WHITE	Current Architecture	make a newer better one, simplify vs. stacking complexities	
WHITE	Surviablility / MILSPEC Requirements	Sensor designed with these requirements in mind vs. in a lab. What's actually required for an attridable sensor	
WHITE	DOTMLPF-P Analysis	Do smarter things, ease of use, prioritize better	
WHITE	Hardware Acq (NDAA Restraints)	Build up US/allied industrial base and supply chains	
WHITE	Data Security Req.	Army defined, what's truly required vs. nice to have	MP
WHITE	Delivery of Sensors	Form factor modular to deployment mechanism (UGA, UAS, human, existing platforms, etc.)	
WHITE	Testing and Validation	Get to field testing ASAP and iterate vs. making something perfect in a lab	
WHITE	Reporting Req. (every minute, hour, day, event driven?)	Ability to tailor to different time scales/requirements	
WHITE	Signature Req. (What are we looking for?)	yes!	
WHITE	Compute (Edge compute, or backhauled to compute)	Both	
WHITE	Signature Managment / Change Management	Have sensors take advantage of being on network, download latest app	
WHITE	What media are we sensing in? (air, water, soil?)	Air	
WHITE	Cost Scaling (lower demand compared to consumer electronics)	Leverage COTS when possible	
WHITE	User interface (receiving data)	Leverage /plug-in to existing systems	
WHITE	User interface (deploying sensors)	Leverage /plug-in to existing systems	

WHITE	Data retention	On sensor: define minimum On network: follow network policy
WHITE	Shelf life	Use them more often, recalibrate/0
WHITE	Environmental considerations (dust, cold, water)	all-weather hardening
WHITE	Investment cost for testing in many environments	More money, more opportunities for simulants, does the simulant match reality
WHITE	Number of detectable hazards	Can't plan for what we don't know. Library updates as we develop ability to send new things
WHITE	How dense can the sensors be before they jam themselves?	Match how dense you need them to be. Better meshing algo
WHITE	Solar panel configuration is more complicated than it first appears	don't use Solar
WHITE	How far does the base station need to be from the sensors for data collection?	See distance/requirements answers
WHITE	Balance frequency band vs primary comms band vs terrain effectiveness vs band	Trade space of requirements, varies by theater
WHITE	Define attritable	Withstand losing them without being impactful to the operation. Need greater coverage so need to drive down cost via volume
WHITE	Self-localization - how does the sensor know where it is?	GPS. Precise atomic clock. Localize via mesh and another device with GPS.
WHITE	Power density	Better battery tech, lower sensor power appetite, sleep mode, etc.. Dependent on what you're sensing
WHITE	Emplacement must result in operational orientation.	Sizing network size and density to allow for some orientation fialures, self-righting capability (weight at bottom?)
WHITE	Spoofing- how do you know if someone is poisoning your data?	Data receipt scheduling, sensor being spoofed (accelerometer) or comms being spoofed (encryption)?
Virtual Team 1	**Battery Life**	Battery life: combination of hardware + firmware. ultra-low power hardware, better firmware, compute architecture, etc. Lastly, more batteries.
Virtual Team 1	Data Processing (Memory size, Compute power, Processor capabilities)	based on other constraints - likely COTS, trimming data before it even gets to our compute
Virtual Team 1	Uninterupted Communications	Mesh networking, frequency hopping, anti-jamming capacity, plan for denied or degraded comms
Virtual Team 1	GPS Denied Environments	Triangulation
Virtual Team 1	Detection without detection	
Virtual Team 1	Communications infractructure and unit connection	
Virtual Team 1	**Taking enough energy with you or harvesting enough in situ**	
Virtual Team 1	Making long range communication link in contested spectrum	
Virtual Team 1	Tradeoff between power, data rate, detectibility. Can you minimize bandwidth	
Virtual Team 2	**Size and weight**	Lower power consumption drives smaller battery. HDI PCBs. Limit the scope of each sensor to only do one thing rather than try to do everything. Move compute off device.
Virtual Team 2	different technologies have different specifications and needs	Cost per sensor module must be further defined
Virtual Team 2	difficult to integrate diverse sensing technologies	Communication methodology based on ATAK
Virtual Team 2	Network robustness at the large scale level	Distributed localized network
Virtual Team 2	False Alarm Rate Reduction	there are microsensor technologies that exist and this project should benefit from previously funded DTRA work / ML modelin + Risk analysis
Virtual Team 2	material science expertise is missing from sensor development	packaging is a big issue to be focusing on
Virtual Team 2	Placed sensor location reporting in GNSS denied area	use different sensors in different context
Virtual Team 2	Cost control	Use COTS components as much as possible. Accept lower fidelity sensors with less capability to cue higher cost sensors.
Virtual Team 2	Battery LIfe (Multi-Modal Energy Depletion)	Passive sensing or mobilize them using drones to chargning stations
Virtual Team 2	Lack of clarity on customer requirements	Anticipate likely threat vectors and minimize target technology scope.
Virtual Team 2	Ecosystem Integration - how well is this defined?	
Virtual Team 2	Operations in denied environments	
Virtual Team 2	Anti-tampering capabilities	
Virtual Team 2	Look at operational cadence of Ukraine: if we spend years developing a	Design the sensor such that it doesn't matter if it gets reverse engineered. There's no secret sauce, there's just a lot of cheap sensors emplaced that are streaming back data.
Virtual Team 2	Environmental conditions - space, deep sea, arctic. Survivability issues	
Virtual Team 2	Unit costs are problematic - especially given the modality requirements	Define attritible. Limit sensor scope, move compute off device.
Virtual Team 2	How are the family of systems defined? Plug-and-play	
Virtual Team 2	Operations need clearly defining - what do these sensors need to actually	Anticipate likely threat vectors and minimize target technology scope.
Virtual Team 2	Battery life remains a critical challenge	Environmental energy harvesting, long range power beaming, higher battery energy density
Virtual Team 2	How can industry stakeholders coordinate product development?	
Virtual Team 2	Commercial sector limitations on IP-sharing	Establish and enforce IP protection data rights, etc.
Virtual Team 2	Comemrcial sector limitatations on profitability	
Virtual Team 2	Environmental clutter - signal infraction	
Virtual Team 2	Adversarial disruption threat	
Virtual Team 2	Detecting system compromization	Physical tamper detection, signed transmissions
Virtual Team 2	Timeliness - speed of reporting constraints vs endurance	
Virtual Team 2	True Positives Rate	Risk modeling, AI/ML, contextual interpretation with other sensors
Virtual Team 2	Data-overload, prioritization, where does the computation go	