Tactical Employment of Ground Robotics + Emerging Technologies

Matthew Boyer, CEO

ZYLTER

www.zylter.com

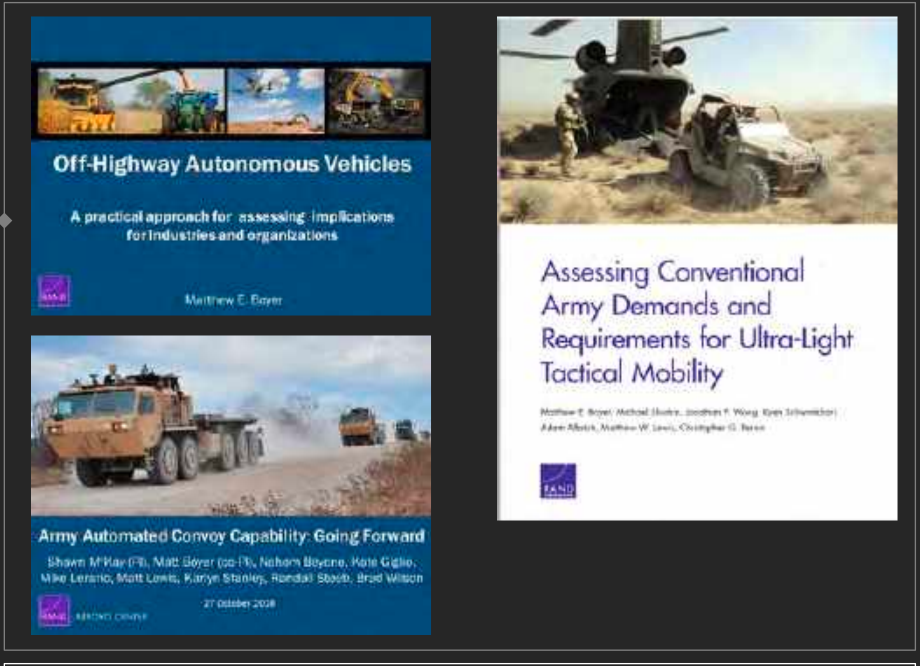
My Tactical + Tech Bio

I have spent 24+ years developing, adopting + employing emerging tech in tactical / field operations:

1995-2009
- ❑ Combat Engineer, Task Force XXI
- ❑ West Point Cadet
- ❑ Armored Cavalry Officer
- ❑ NG Engineer Officer

2009-2017
- ❑ RAND analyst /study lead / published author
- ❑ Led strategic studies to guide Army/ DOD adoption of emerging tech

2017-
- ❑ Co-founder / CEO of Zylter
- ❑ Strategic advisor to early-stage and growth tech companies:
  - Martin UAV, Talespin, Next Future Transport, SaySo, etc.



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Zylter guides + supports tactical tech adoption

We enable successful adoption of emerging tech and design of sociotechnical systems (STS)

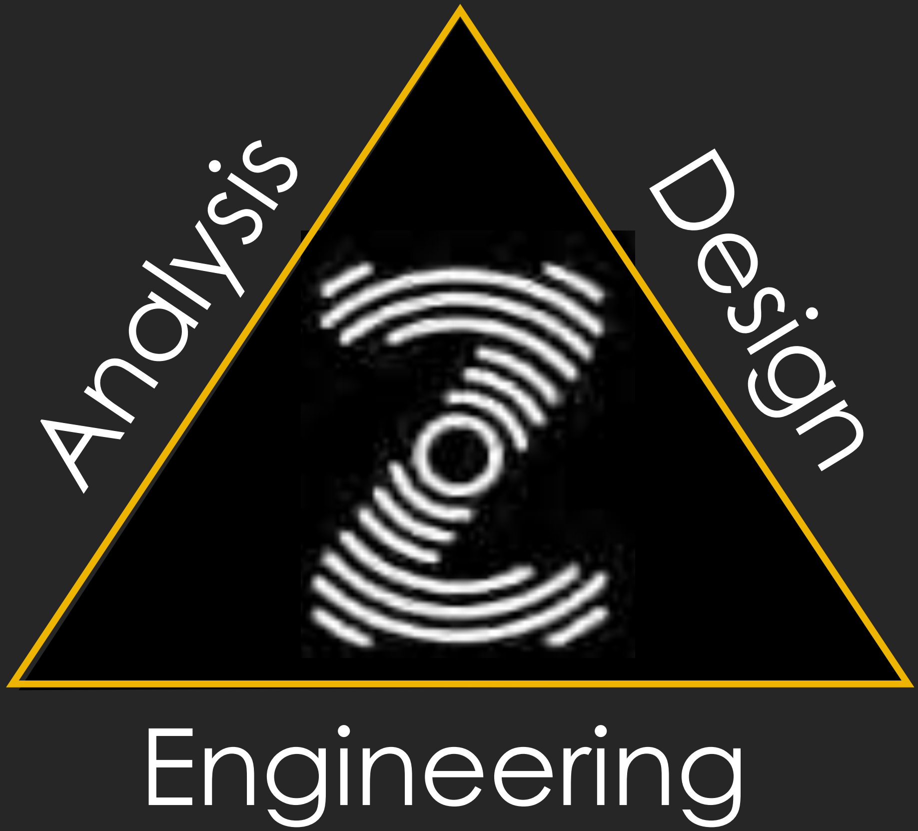
Industry Domains:

- Defense
- Logistics
- Engineering
- Energy

Key Tech Areas:

- Autonomous systems
- Extended reality (VR, AR, etc.)
- AI / machine learning
- IOT / connected devices

Zylter Cross-Functional Capability Space



What is a sociotechnical system?

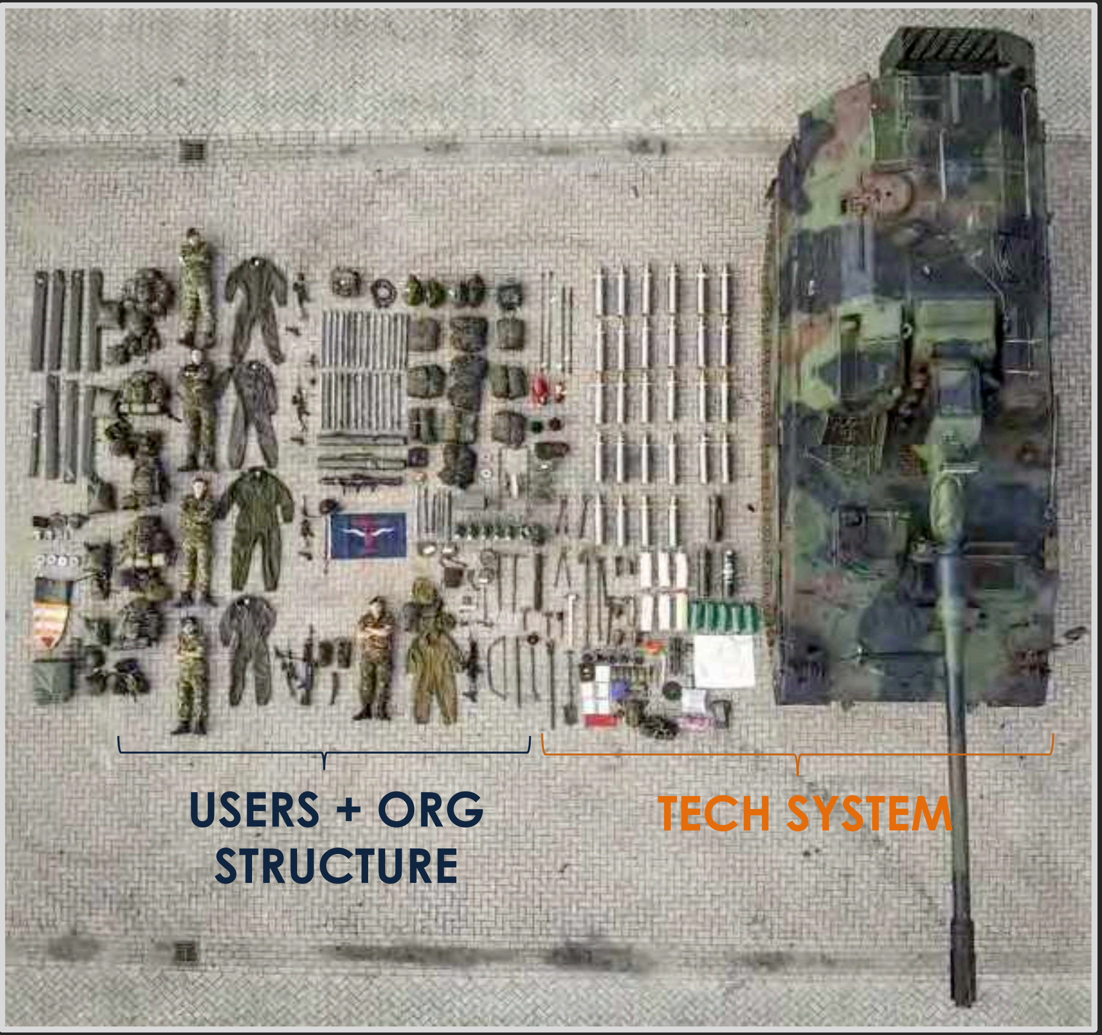
STS Composition + Needs:

A complete tech-enabled operating capability

Each element from warfighter to brigade is a discrete STS

New tech usually requires STS changes that require commercial solutions

STS changes generate both new requirements and commercial opportunities to address them



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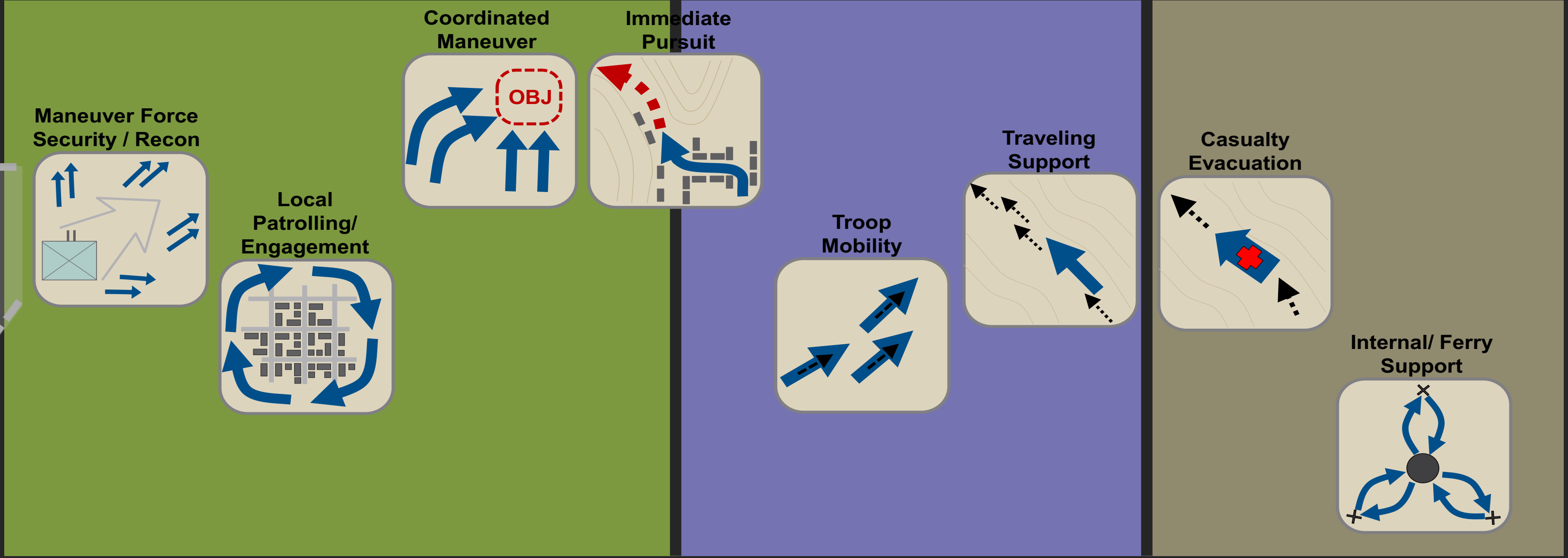
STS Use Cases:

Each addresses a unique application of a capability

Each tech use case addresses a discrete set of tasks with STS requirements

SMET Operating Modes + Discrete Applications

MANEUVER	MOBILITY	SUPPORT
An *engagement platform* to conduct tactical tasks (weapons employment, reconnaissance, engagement, etc.)	A *carrier platform* to enhance mobility by moving personal or cargo to point of need	A *cargo platform* to execute support functions on the move or in a fixed site (e.g., FOB or FARP)



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Emerging Tech Systems:

Emerging tech creates new STS capabilities + needs

Squad Multipurpose Equipment Transport (SMET)

Advanced materiel solutions leverage emerging tech to improve STS capabilities

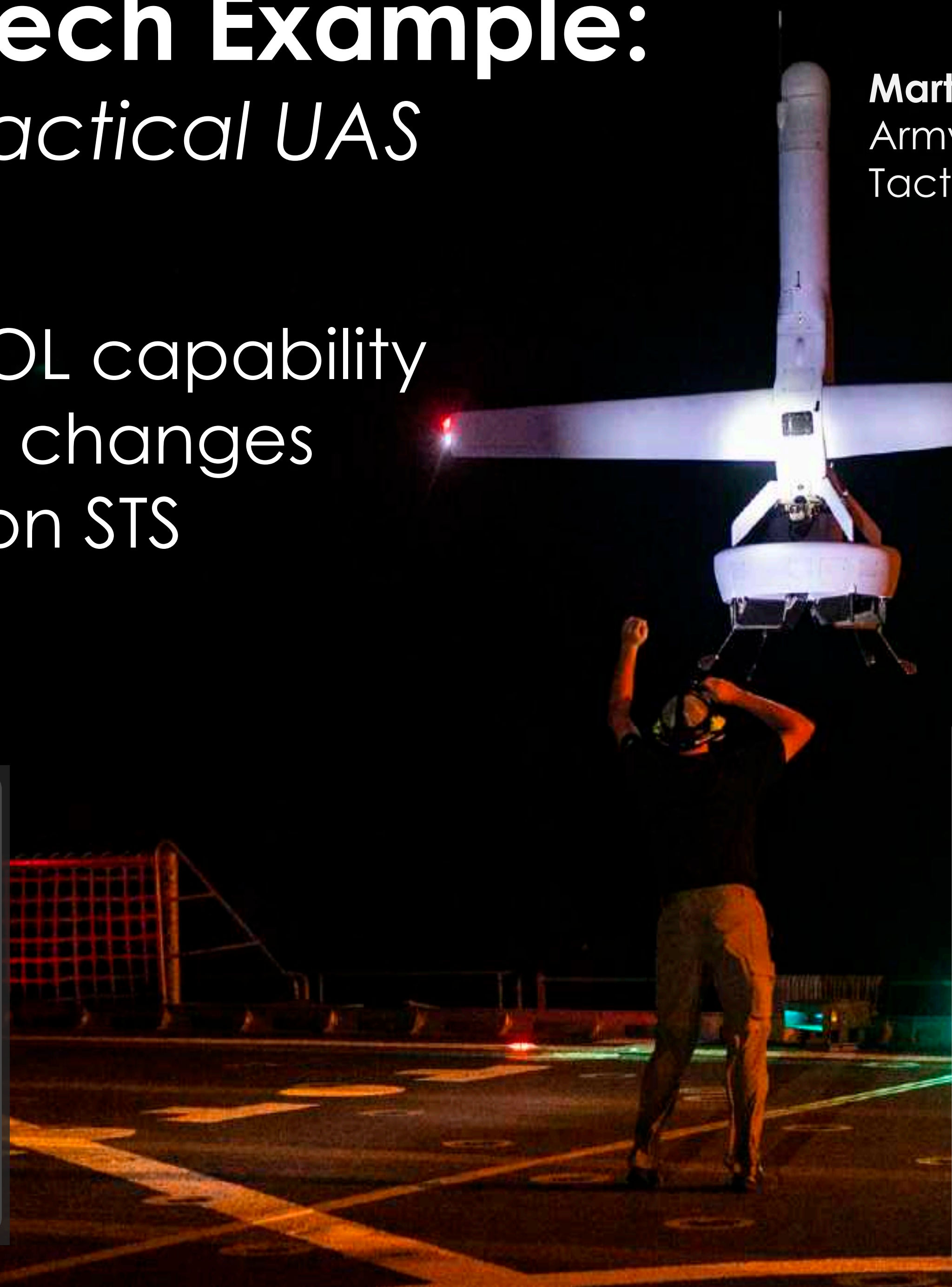
- Tech changes require modification of the entire STS
- Automation displaces some STS tasks while modifying and creating others

Major tech changes generally require a suite of new STS capabilities to support them:

- Interoperability with legacy systems
- Add-on packages to address other use cases
- Live/virtual individual + collective training
- Life-cycle solution support

Emerging Tech Example:
Army Future Tactical UAS

VBAT's true VTOL capability fundamentally changes the UAV Platoon STS



Martin UAV V-BAT
Army Future
Tactical UAS

V-BAT Aircraft + GCS

Army legacy Tactical UAS Capability (Shadow)

Task / Processes:

Task needs + changes guide solution design

PLS secondary load drop with human execution and guidance

Task analysis requires detailed deconstruction of jobs and actions

Most commercial operations do not systematically define tasks/processes like DOD does

Requires blending of industrial design and worker expertise to understand the implicit needs

Major tech changes allow for redesign of tasks and enabling capabilities

Major tech changes create new tasks and associated STS needs

Automation tech executes some STS tasks, but also generates new STS requirements

Task changes generate needs for needs enabling solutions

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Task / Processes Example:

Task implications of Leader-Follower automated convoy ops

PLS Leader-Follower with applique kit

ART 1.3.3 Conduct Tactical Convoy

Combat operations in which forces and materiel are moved overland from one location on the battlefield to another while maintaining the ability to aggressively respond to enemy attempts to impede, disrupt, or destroy elements of the convoy.

pre-convoy tasks — *post-convoy tasks*

Organizational Control

- Supervise Transportation Platoon Operations (55-2-4558)
- Redirect Vehicle Operators) (55-2-0016)
- Manage Transportation Operations (55-2-4557)
- Set Up Truck Platoon (55-3-0007)

Convoy Operation

- Conduct Onward Movement Activities (55-2-4813)
- Conduct Tactical Convoy (55-2-4003)
- Maintain Communications (63-2-4017)
- Transport Palletized Cargo (55-3-0013)
- Conduct a Withdrawal (Platoon-Company) (7-02-9009)

Convoy Security

- Defend Convoy Elements (55-2-4006)
- Conduct Actions at Danger Areas (7-03-9017)
- Conduct Actions on Contact (7-03-9013)
- React to a Possible Improvised Explosive Device (IED), Vehicle Borne IED, Suicide VBIED or Person Borne IED (5-03-3091)

Maintenance & Repair

- Conduct Preventive Maintenance Checks and Services (43-2-4575)
- Perform Field Maintenance (43-2-4552)
- Perform Vehicle Recovery (43-2-0001)
- Conduct Support Maintenance Operations (43-2-0029)
- Perform Battlefield Damage Assessment and Repair (43-2-0002)
- Perform Controlled Exchange of Repair Parts (43-2-4394)
- Perform Service Operations (43-2-0030)

Legend

- Motor Transport Service & Operation Function
- Tasks explicitly examined in workshop
- Other related or similar tasks

184 collective tasks for PLS Med Truck Company

Many not addressed by Leader-Follower capability

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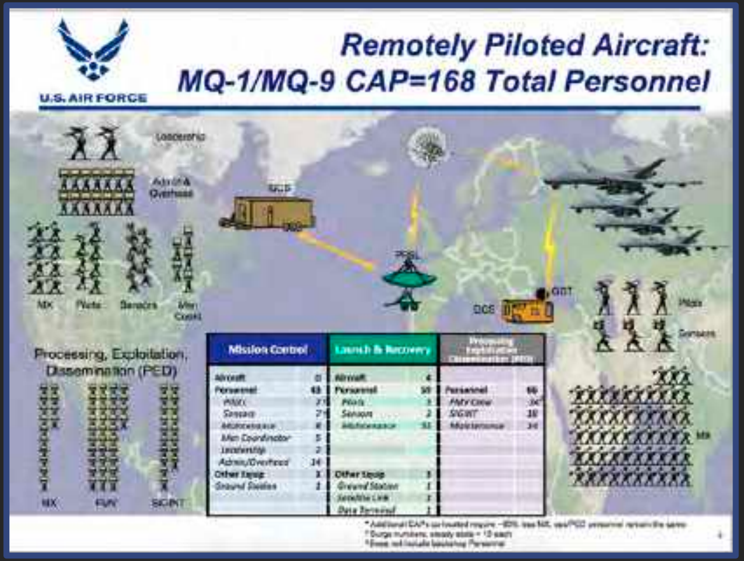
Organizing Structure:

Task redistribution + cognitive load management



MQ-1/-9 personnel requirements

Automation of tasks requires redistribution of remaining tasks

- Must account for all potential modes of STS employment
- Disproportionate automation of lower-order tasks
- Cognitive load a key concern for remaining personnel

The new org structure often demands new enabling capabilities

- Command + control capabilities
- Information transmission, synthesis + management
- Interoperability
- Collective training resources

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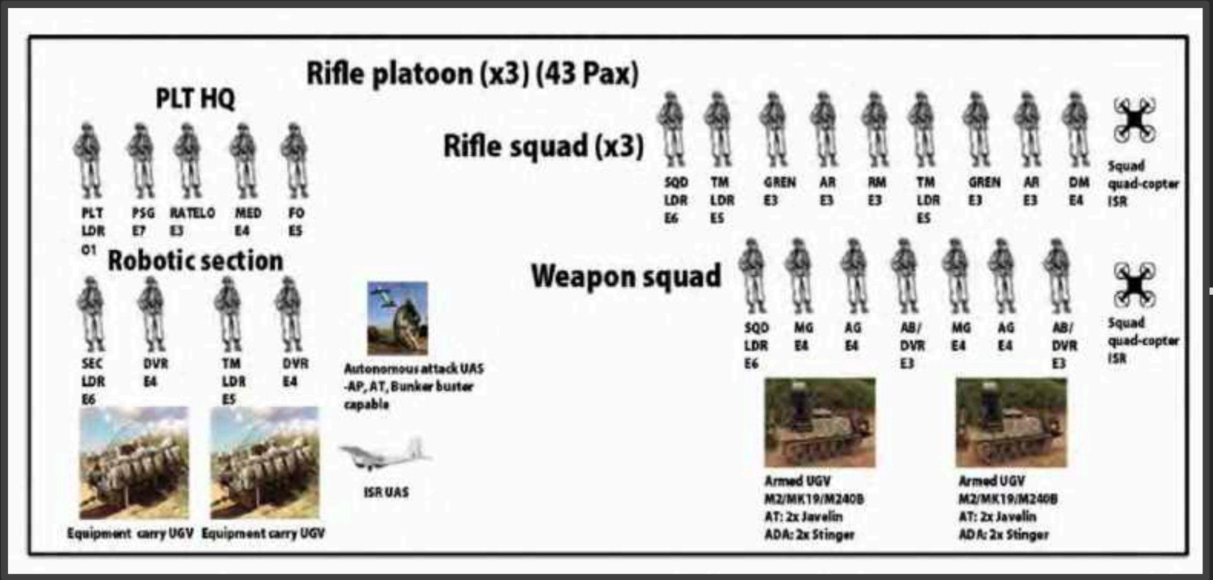
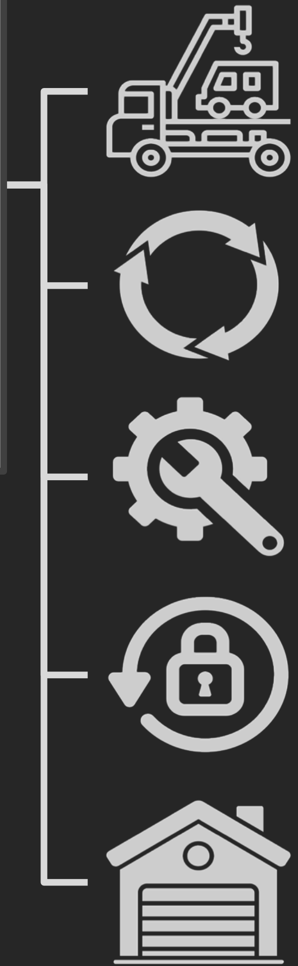
Organizing Structure Example:
Platoon capability requiring battalion-level support

Robotic-Enabled Rifle Platoon Concept



SOURCE: Maj. Zachary L. Morris, 2019. , "Developing a Light Infantry-Robotic Company as a System"

External Support Requirements



- **Deployment + operational mobility**
- **Sustainment**
- **Maintenance, Repair + Recovery**
- **Physical + Cyber Security**
- **Facilities**

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Workforce / Users:

Technology requires new workforce KSAs + training

VR/AR workforce training design

Tech often automates lower-order skills while increasing cognitive demands for remaining humans

- Tech systems can simultaneously reduce, displace and increase personnel
- Will increase cognitive load and competencies required for personnel

Tech-enabled STSs require enhanced training + cognitive support capabilities

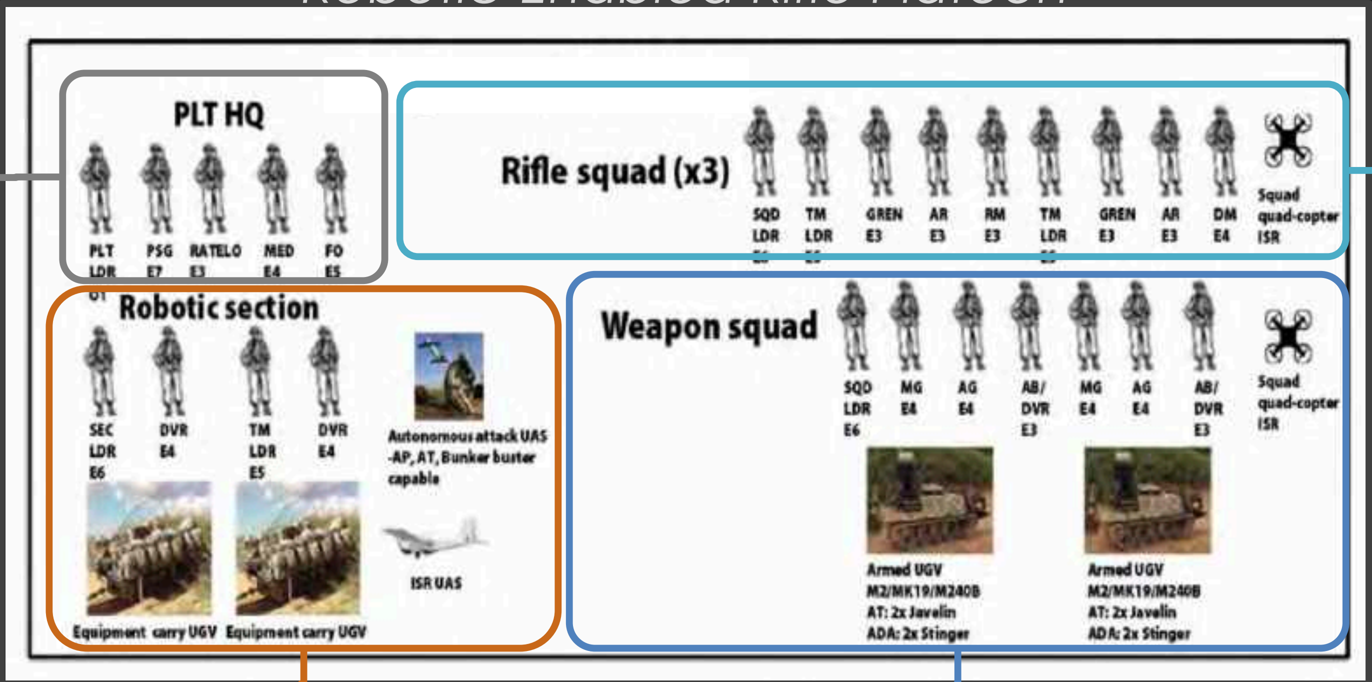
- Virtual / augmented reality key resource for STS training
- Increased need for tech-enabled recruitment, development + retention

Workforce / Users:

Competency & training needs for robotic rifle platoon

HQ SECTION | Collective training to understand and employ robotic systems

Robotic-Enabled Rifle Platoon



RIFLE SQD | Collective training to maneuver with or in support of robotic systems

ROBOTIC SECTION | KSAs to maintain and operate platoon robotic transport capabilities

WEAPONS SQD | KSAs to maintain and operate platoon robotic weapons platforms

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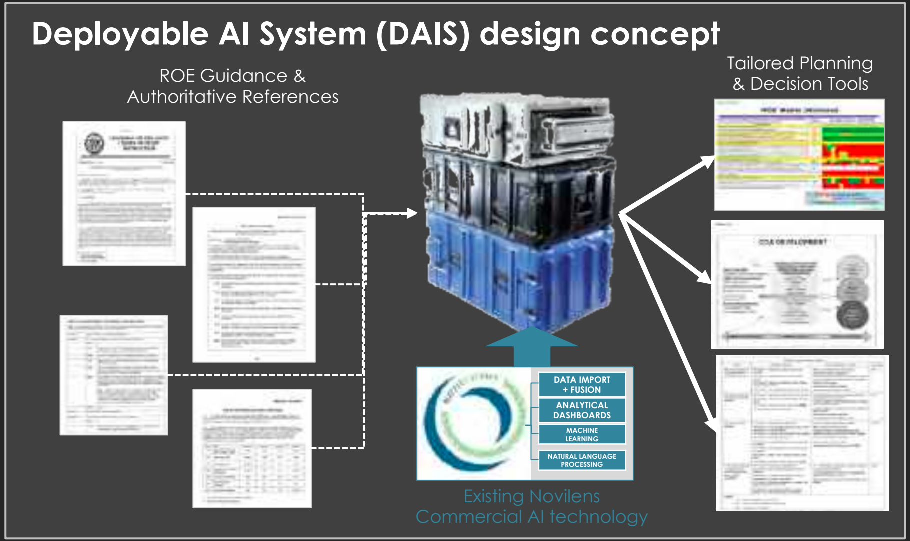
Operating Environment:
Deployable AI System for austere / secure ops



DAIS capability for robust tactical decision-making

Operating environment includes a range of external factors influencing STS employment

- Physical terrain
- Infrastructure
- Electromagnetic
- Regulatory / policy
- Cultural
- Etc.

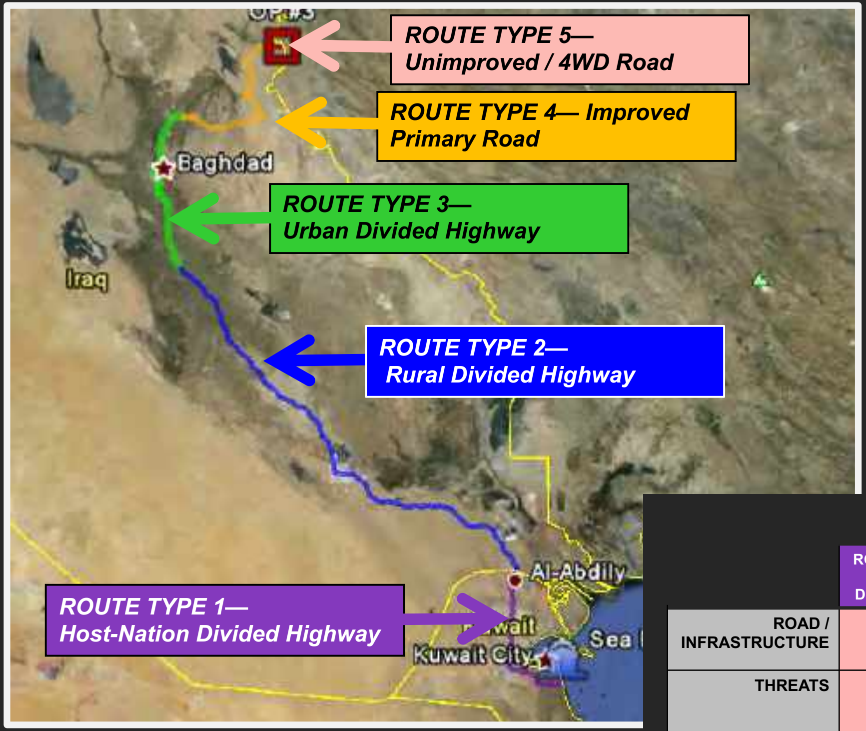
These operating environment factors can heavily influence solution requirements

- Some KPPs based on environmental requirements
- Example: Bandwidth/ spectrum limitations

Operating Environment:

Vary environments for automated convoy ops

Varying operating environments dictate STS requirements for effective force employment



Iraq operating environments for automated convoy operations

ANTICIPATED CHALLENGE FOR AUTONOMOUS TRUCKS

	ROUTE TYPE 1— Host-Nation Divided Highway	ROUTE TYPE 2— Rural Divided Highway	ROUTE TYPE 3— Urban Divided Highway	ROUTE TYPE 4— Improved Primary Road	ROUTE TYPE 5— Unimproved / 4WD Road
ROAD / INFRASTRUCTURE	LOW	LOW	LOW	MED	HIGH
THREATS	LOW	LOW	MED	HIGH	MED
HAZARDS	LOW	MED	LOW	LOW	LOW
CIVILIAN INTERACTIONS/ CONCERNS	LOW	LOW	HIGH	HIGH	LOW
CONVOY COMPOSITION	LOW	LOW	LOW	MED	HIGH
OTHER ISSUES	MED	LOW	LOW	LOW	MED
COMPLEXITY FOR AUTOMATION	LOW	LOW	MED	HIGH	HIGH

Key implications for development & employment of combat vehicle technology

Design of new systems + enabling solutions must consider the entire STS

New capabilities often generate unanticipated STS changes + requirements

Identifying all the first- / second-order STS impacts requires a systematic approach →

Zylter Methodology for STS Analysis	
1	Define scope of the socio-technical system (STS) to examine
2	Describe key aspects of STS operating environment
3	Define the implications of the new technology for STS tasks & functions
4	Describe the planned technology changes for the STS
5	Determine required to changes to the STS work structure
6	Define the new STS personnel requirements
7	Identify and prioritize key implications for adaptation of the av-enabled STS

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Emerging commercial opportunities to address STS needs of evolving forces

Key commercial opportunities to address STS needs associated with tactical robotics include:

Add-on or applique capabilities for emerging robotic platforms / PORs	▪ Enabling tailoring of robotic platforms to other use cases ▪ Technology to enable / increase interoperability with other legacy and emerging systems
Enabling capabilities to address secondary STS impacts	▪ Virtual / augment training ▪ Human-machine interface ▪ Sensor fusion ▪ Data collection, transfer and analysis ▪ Intelligence augmentation with cognitive aids and decision-making tools ▪ Machine-cargo interface (e.g. load sensing) ▪ Simulation environments for testing and validation

Create. Technology. Zylter.

Matthew Boyer

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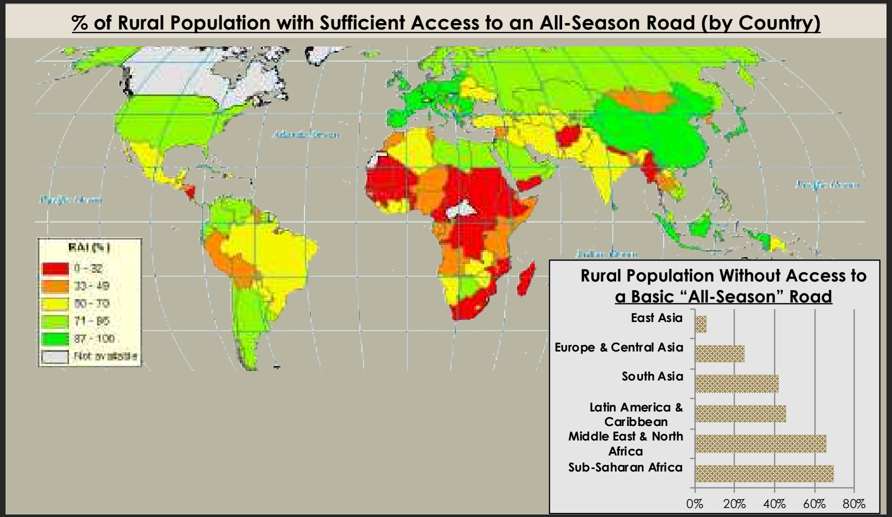
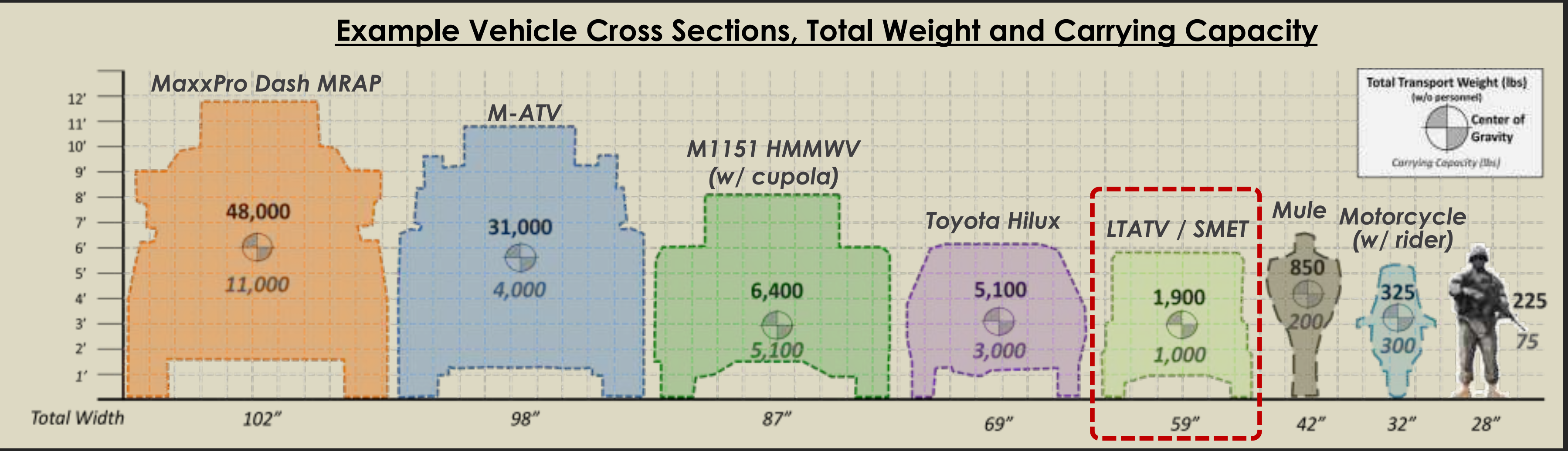
Operating Environment:

SMET supports mobility in rough & constrained areas

SMET is designed to support and enhance dismounted forces in constricted terrain

Makes track width is an essential attribute





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Our free reference guide describes the process for commercial leaders to find and adopt emerging tech

Link to Download: Link to guide download
Link to Zylter Publications: Link to Zylter Publications

1. IDENTIFY PRIORITY ORGANIZATIONAL + USER NEEDS
2. IDENTIFY + ASSESS EMERGING CAPABILITY ALTERNATIVES
3. BUILD BUSINESS CASE FOR EMERGING SOLUTION ADOPTION
4. TRANSLATE USER NEEDS INTO PRODUCT / SERVICE REQUIREMENTS
5. SOLICIT + ACQUIRE EMERGING TECH PRODUCT / SERVICE
6. DEPLOY + SUPPORT SELECTED SOLUTION

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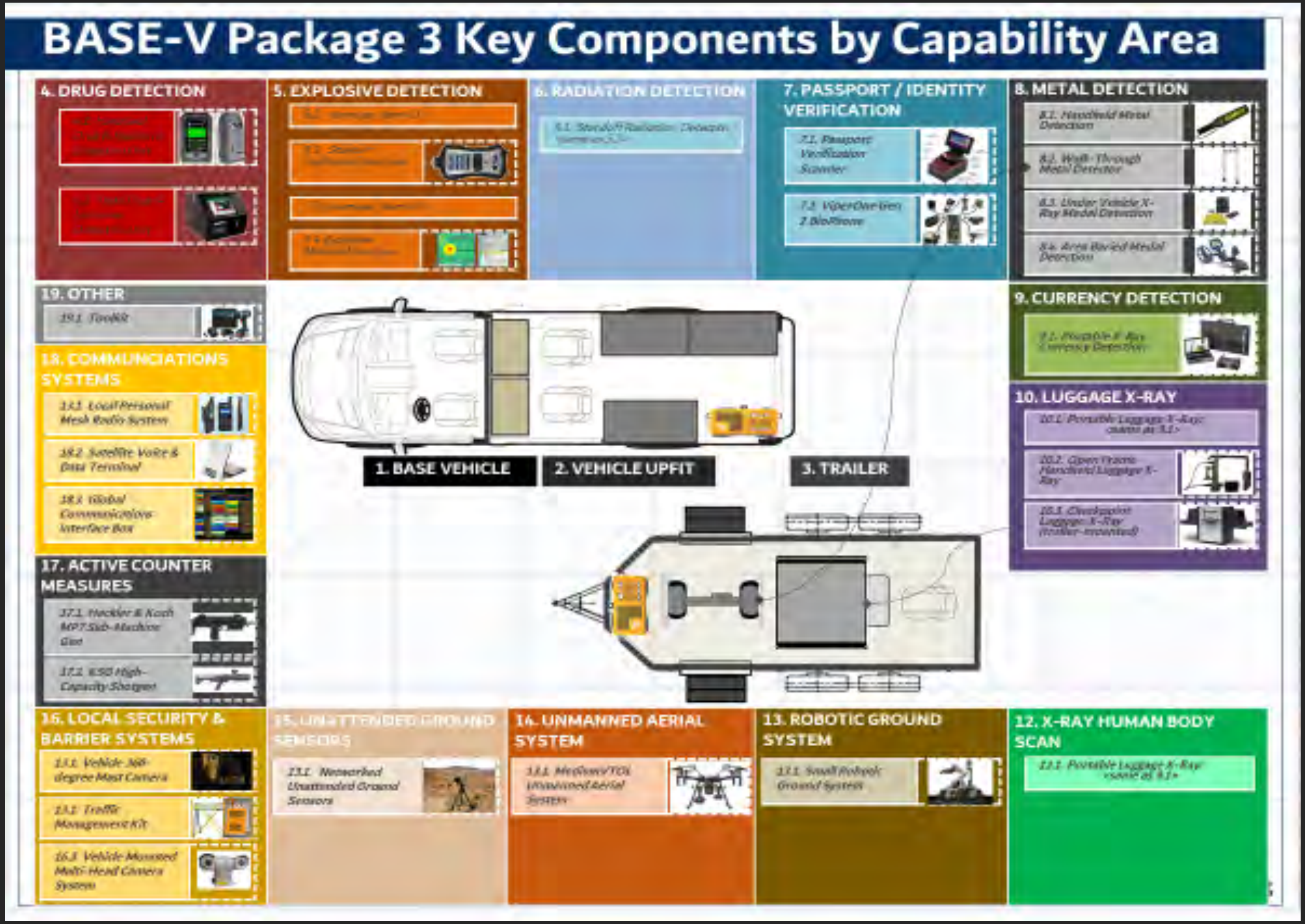
Zylter Project Example UAE Border Security Vehicle Design & Technology Integration



The BASE-V system includes the set of capabilities required to address key operational requirements

	CAPABILITY AREA	VAN 1	VAN 2	VAN 3
CORE CAPABILITIES	DRUG DETECTION	X	X	X
	EXPLOSIVE DETECTION	X	X	X
	VIDEO SCOPE	X	X	
	PASSPORT / IDENTITY DETECTION	X	X	X
	CURRENCY DETECTION	X	X	X
	LUGGAGE X-RAY	X		X
	METAL DETECTION		X	X
	MOBILE / HANDHELD RADIATION DETECTION	X	X	
	X-RAY HUMAN BODY SCAN			X
SUPPORTING CAPABILITIES	*ROBOTIC GROUND SYSTEM*		X	X
	UNMANNED AERIAL SYSTEM		X	X
	UNATTENDED GROUND SENSORS			X
	LOCAL SECURITY & BARRIER SYSTEMS	X	X	X
	ACTIVE COUNTERMEASURES	X	X	X
	COMMUNICATIONS	X	X	X

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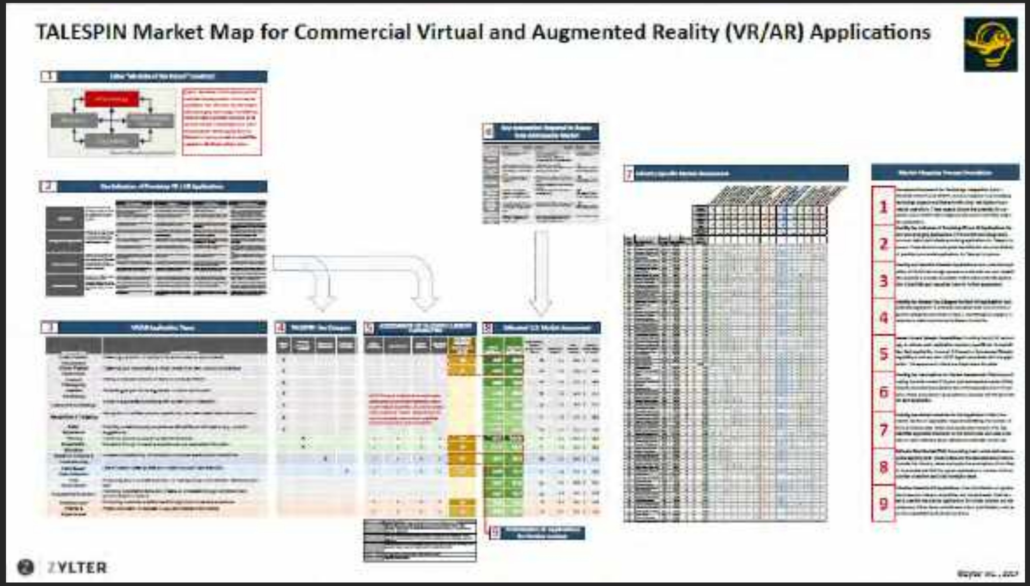
Zylter Project Example Commercial Virtual / Augmented Reality Market Development



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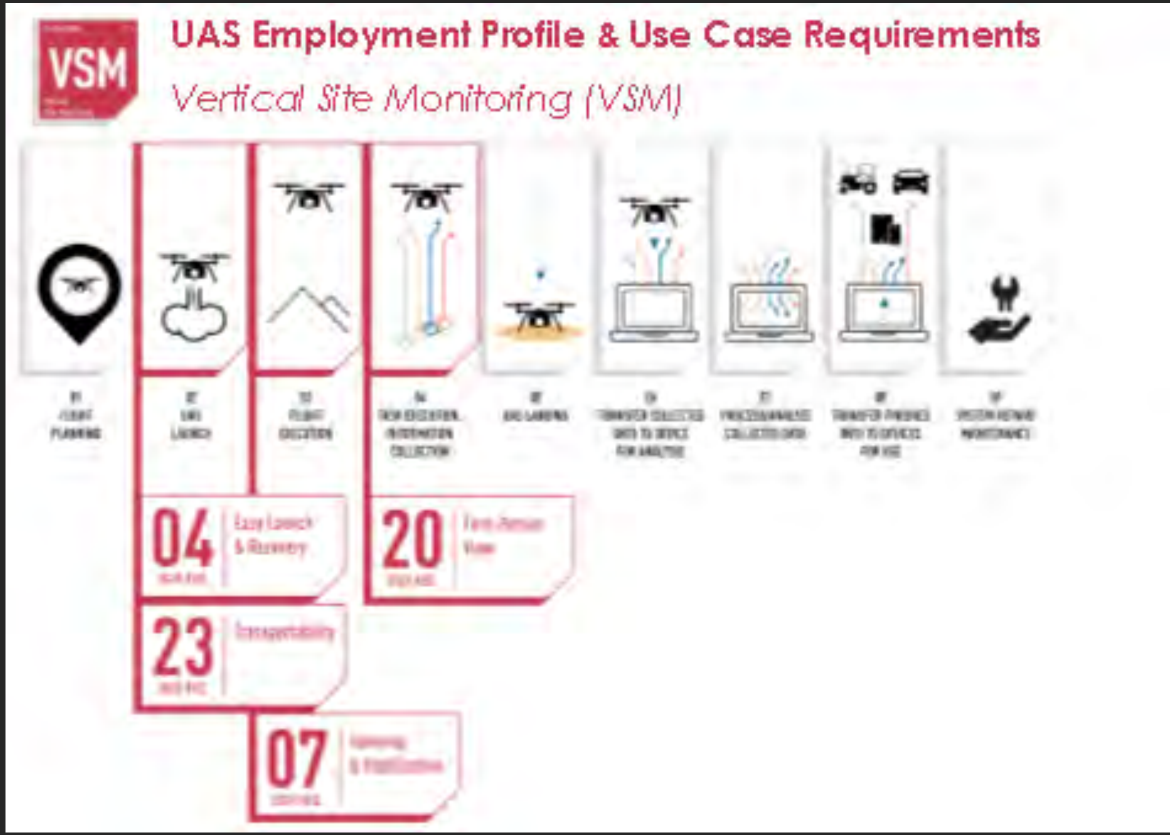
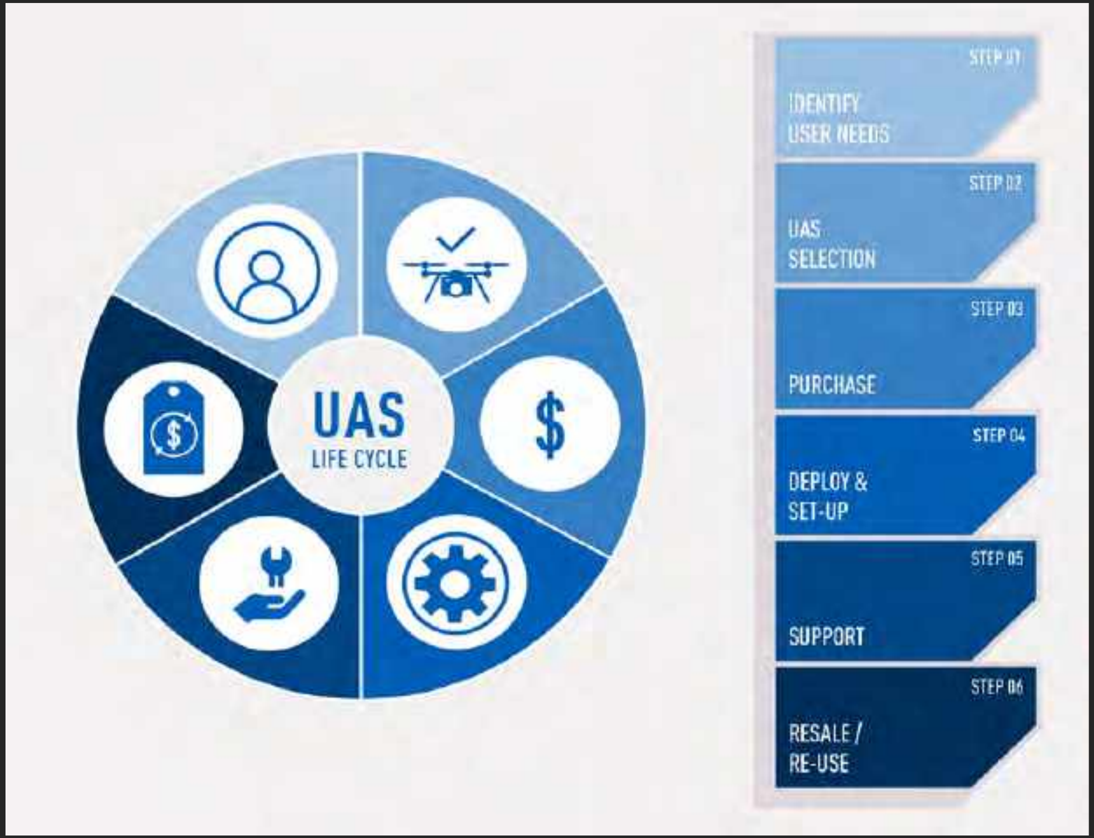
Zylter Project Example Unmanned Aerial System Employment Profile & Support Life Cycle Design





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Zylter Autonomous Ground Vehicle Market Research Database

Zylter Autonomous Vehicle Market Research Database

Industry Verticals
- Engineering
- Logistics
- Energy

Socio-Technical System Areas
- AV technology
- Tasks
- Workforce
- Work structure
- Operating environment
- General

Technology Capability Areas
- Technology business case
- Computing / cognition
- Software
- Proximity awareness
- Navigation / positioning
- Environment
- Telematics
- Obstacle avoidance
- Autonomous operation
- General

Support Capability Areas
- Communications
- Infrastructure
- Maintenance
- Sustainment
- Training
- Fleet management
- Data analysis / diagnostics
- General

Motivating Factors
- Safety
- Economy
- Efficiency
- Productivity
- Workforce requirements
- Enviro impacts
- Speed

System Design Considerations
- Interoperability
- System performance
- Human-machine interaction (teaming)
- Site development
- Testing & validation
- Task selection
- General

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TECHNOLOGY READINESS LEVELS DEFINITIONS

	TECHNOLOGY READINESS LEVEL	DEFINITION
TRL 7	**System prototype demonstration in an operational environment**	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.
TRL 8	**Actual system completed and qualified through test and demonstration.**	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.
TRL 9	**Actual system proven through successful mission operations.**	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.

http://acqnotes.com/acqnote/tasks/technology-readiness-level

https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf

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