# CMU-SEI Edge Enabled Tactical Systems

## Carnegie Mellon Software Engineering Institute; Advanced Mobile Systems Team



**2+** Biomedical sensors on the injured soldier generate request for Medevac support.

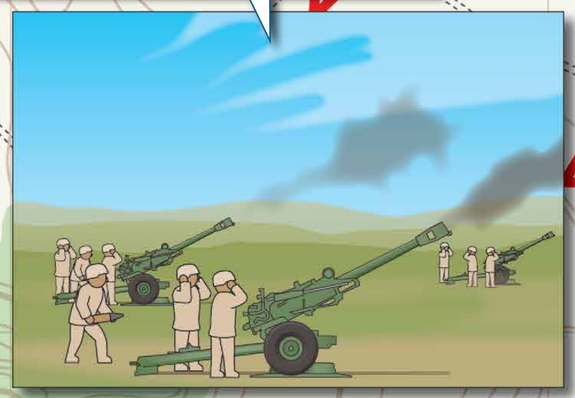
**5+** Horizontal sharing across units notifies additional forces to identify persons of interest (POIs).

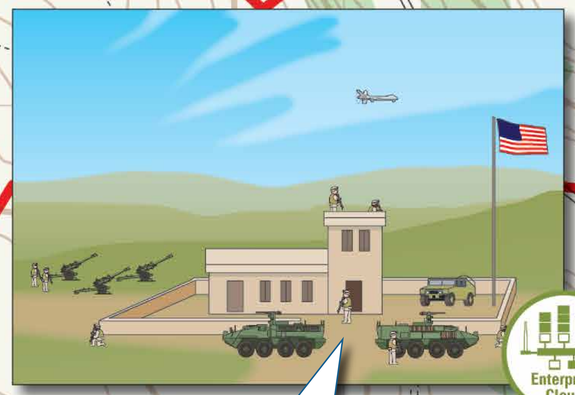
Execution of this scenario generates and consumes large amounts of information.

**4** The ambush is suppressed. UAVs are able to locate the best landing zone for the Medevac.

**2+** Rapidly-deployed sensors swarm the ambush site to locate the attackers.

**3** Sensed context information generates a call for fire support—accurate coordinates are enhanced by data from the deployed sensors and human input.






**0** Cloudlets located in the forward operating base (FOB), UAVs and vehicles provide face recognition capabilities, social network analysis for POI identification, and targeting information.

**1** A patrol is been ambushed and a soldier is critically wounded.

**5+** Hostile units disperse and try to flee the area.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Guiding Scenario
SEI AMS Team February 2013

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## Current Research Capabilities

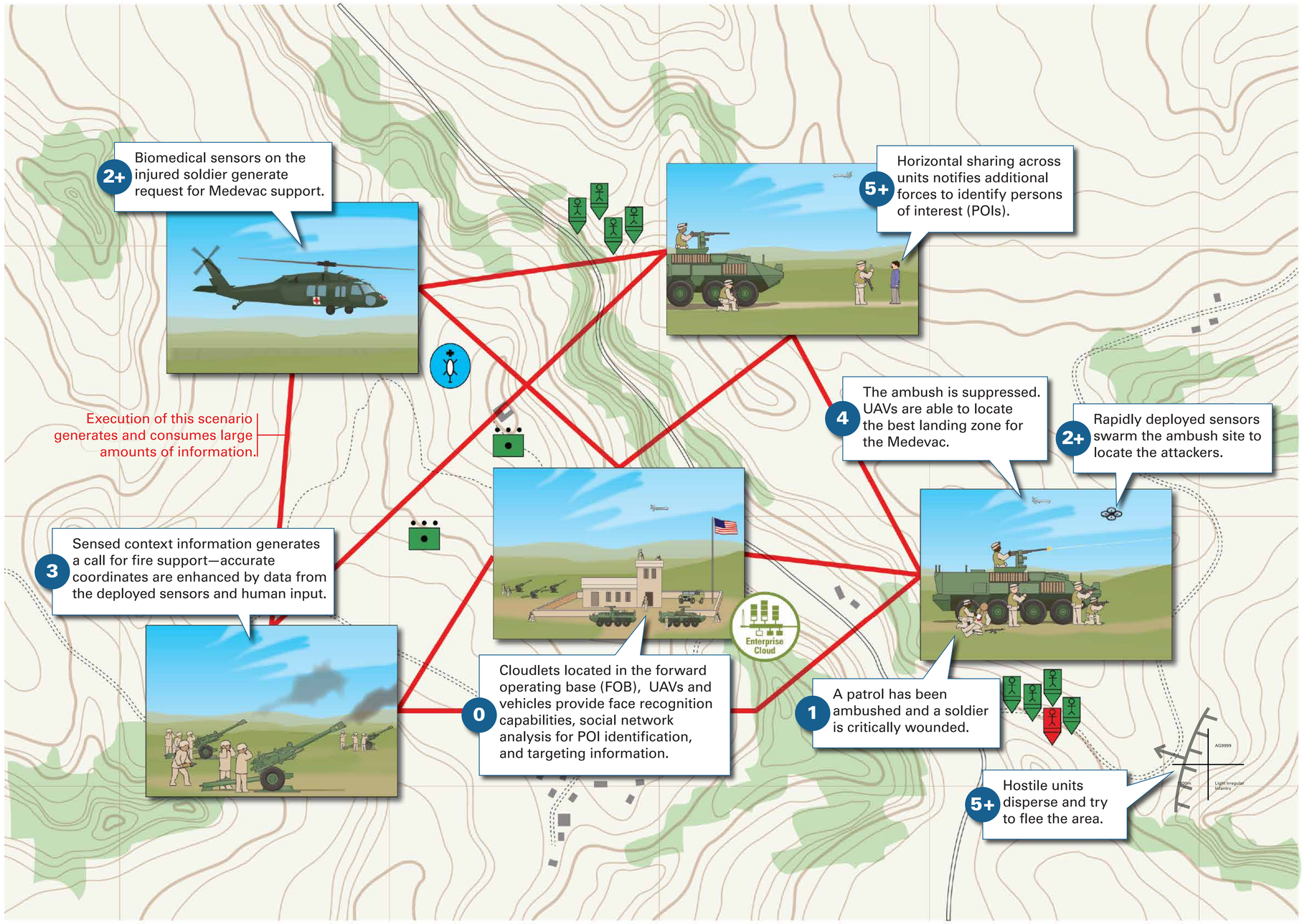
**Cloudlets for Cyber-Foraging**
Forward-deployed, virtual machine (VM) "cloudlets" that can be hosted on vehicles or other platforms and provide (1) infrastructure to offload computation from wearable devices and remote sensors, (2) forward data-staging for a mission, (3) data filtering to remove unnecessary data from streams intended for dismounted warfighters, and (4) collection points for data heading for enterprise repositories.

**Information Superiority to the Edge (ISE)**
Architecture and middleware that supports squads of soldiers and first responders by;
1) collecting data from opportunistic real time handheld and worn sensors,
2) deriving context information from this collected data and pre-staged local storage,
3) using this context information to optimize the use of resources across the unit (e.g., battery, processing), and
4) leveraging this context information via configurable rules to automate timely, targeted information sharing with horizontal and vertical units.
All of this support reduces the cognitive load on the warfighters.

**SMASH**
Architecture, middleware, and algorithms that invert the drone control paradigm, from multiple operators per drone to multiple drones per operator for tactical units, by supporting inexpensive, easy-to-control platforms and sensors that provide IR, video, and other data in support of mission-related tasks. In addition, SMASH manages available battery and bandwidth to extend sensor life, minimize network congestion, and actively bridge gaps in networks to extend reach beyond immediate wireless range.

**Edge Analytics**
Architecture and algorithms to provide rapid (minutes) feedback to warfighters about persons of interest and dangerous situations by supporting (1) timeliness vs. fidelity tradeoffs where faster, approximate algorithms provide more rapid feedback, (2) smart data filtering to reduce data size, with forward caching of likely data and intermediate results, (3) dynamic workflow construction that adapts to needs and resources, and (4) near-real-time analysis of streaming text, to expand to video stream analysis and scene recognition.

**eMontage**
Architecture that supports rapid incorporation of new data sources, rule-based and user-directed filtering and dissemination of data, and map-based display on handheld and other devices.




## Notes

**Network Infrastructure**
We are collaborating with ARL to develop and prototype next-generation architecture, from command post to dismounted warfighters, supporting VM deployment of capability and cyber-foraging strategies.

**Cognitive Load:**
All of our current and future projects have (and will have) design goals to enhance the capacity of squad members while reducing cognitive load on the individuals and the team. Initial results measuring before and after cognitive load for the ISE prototype will be available in early August.

## Potential Enhancements

**Sharing information among squad members and exploiting the distributed nature of the dismounted squad:**
Enhance the ISE capability and rules set to 1) extend the capability to share voice, video, images, and to support shared real-time map-based markup, and 2) support cyber-foraging between handheld/wearable devices to conserve power and improve performance.

**Capturing physiological data, operational status, location, motion, and gestures:**
Extend existing ISE group context awareness infrastructure and prototype (captures and shares sensor and status data within small military teams) with interfaces for other sensors to enhance capture of physiological data, operational status, location, motion, and gestures.

**Detailed situational awareness from squad to command post:**
Integrate the ISE prototype (group context awareness), Edge Analytics prototype (local squad analytics and situational awareness), and eMontage prototype (information filtering, distribution, and display) to create the ability for ISE data from a squad to be locally analyzed (Edge Analytics) and fed to eMontage (when reach-back to the command post or cloudlet is available), where it can be "mashed up" with other data (e.g., information from other squads, contacts with enemy forces) to provide a unified view (eMontage at the command post).

**Application of unmanned systems to build a 3-D world model of the squad's area of operations:**
Integrate GAMS with ISE and eMontage to build a capability where multisource sensor data from squad members and unmanned systems, filtered and manipulated by eMontage, is used to construct a world model of the area of operation. Real-time video scene analysis for real-time settings will be incorporated a later date.

**Anticipate the tactical situation and maneuver:**
Integrate information in the ISE prototype about the mission, including routes, way-points, and roles with the capabilities of GAMS drones and sensors to support small drone swarms and sensor networks that extend the reach of humans by performing "look-ahead" along the mission route, identifying dangerous situations, and scouting alternative routes.



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