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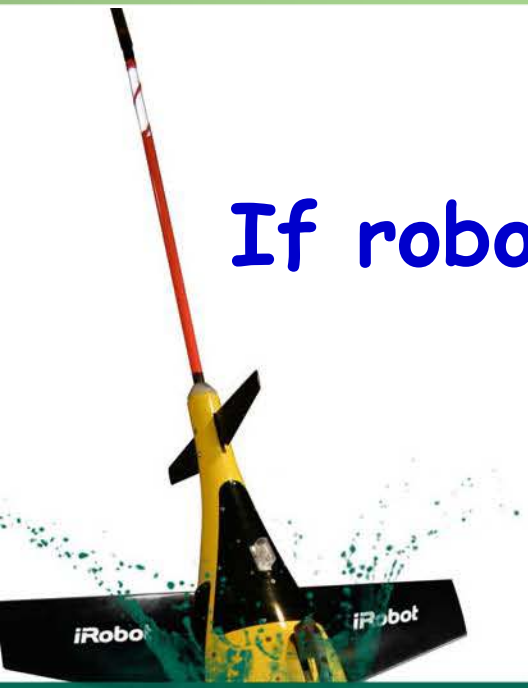
Robots that make a difference



If robots could talk on the network, what would they say?

Joe Dyer
President, Government & Industrial Division
iRobot Corp

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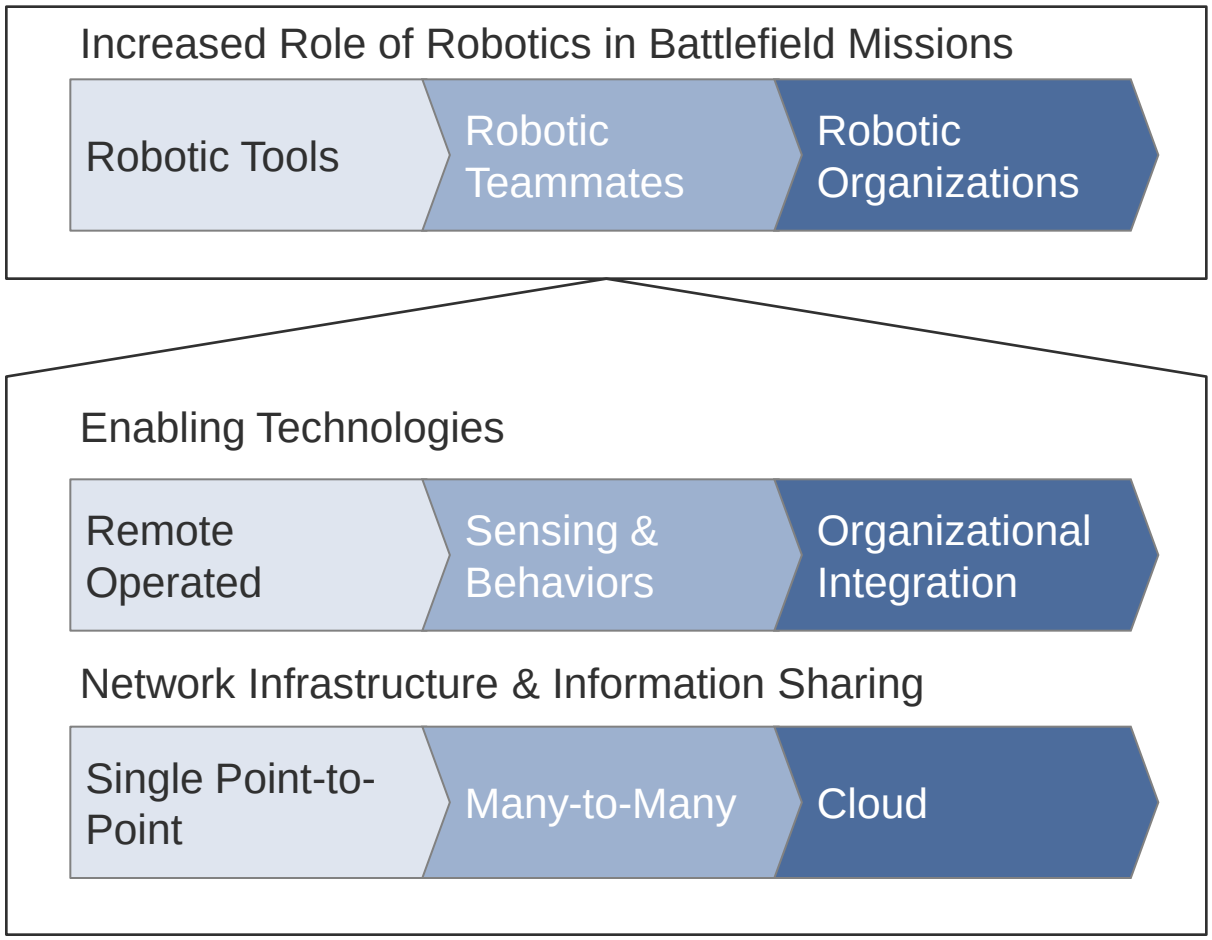
Technology Advances Will Grow Role Of Robots



Today

Next Horizon (5+ years).

Horizon After Next (10+ years).

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- **Teleoperated Robotic Tools**
- Semi-Autonomous Robotic Teammates
- Autonomous Robotic Organizations
- Conclusion

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Today Robotic Tools Perform Important But Limited Tasks

- Established CIED, ISR, and tunnel exploitation missions.
- Emerging capability in MOUT.
- One to one controller/robot relationship.

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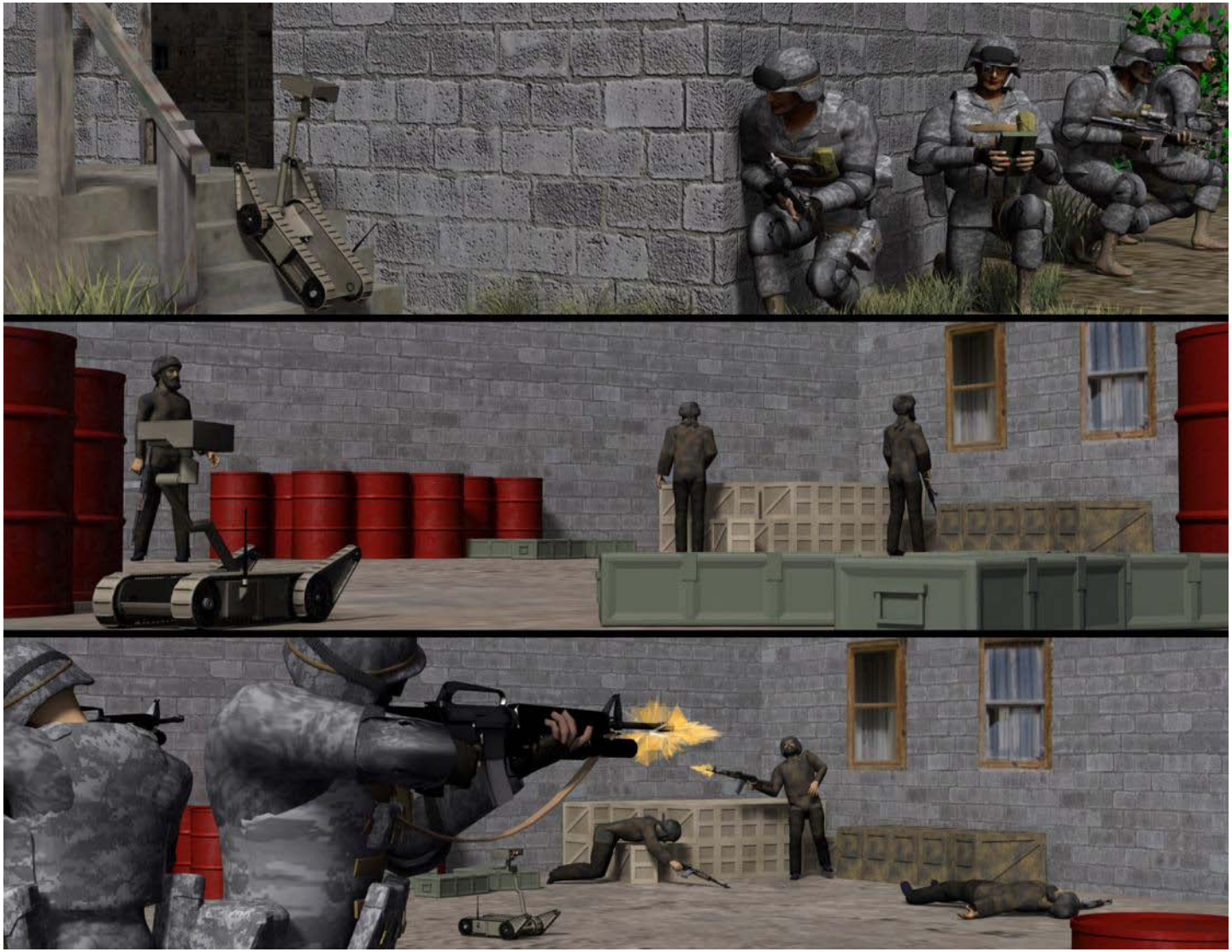
Specifics of Potential CONOPS

Entering the building.

Developing the situation.

Clearing.



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Entering the Building

In this setting, the robot:

- Provides stand-off.
- Reduces potential escalation.
- Provides lower profile penetration of the structure.
- Provides early warning of entry obstacles/booby traps.

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Developing the Situation

New SA gleaned from robot enables/supports:

- Identification of occupants & their activities.
- Assists in determination of intent.
- Reveals room configuration.
- Identifies entry and exits into the room.
- Supports enhanced COA development, e.g.:
  - Use of non-line of sight engagement.
  - Select alternate entry.
  - Explosive materials mitigation.
  - Refine entry SOP.
- Determine follow-on clearing strategy.

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Clearing

Use of the robot provides new capabilities:

- Reduces potential collateral damage.
- Optimizes entry position.
- Reduces potential for sympathetic detonation.
- Reduces unknown obstacles/trip-wires.
- Increases speed of operation.
- Provides advance location of targets.
- Speeds information exploitation.

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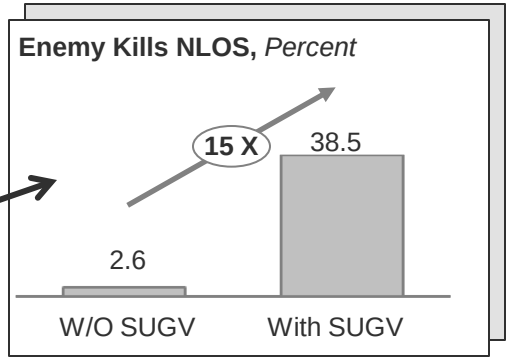
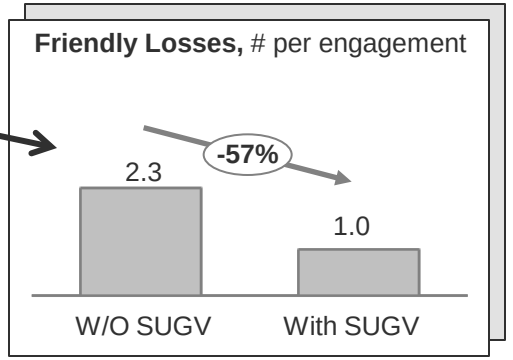
Today's Robots Make A Difference

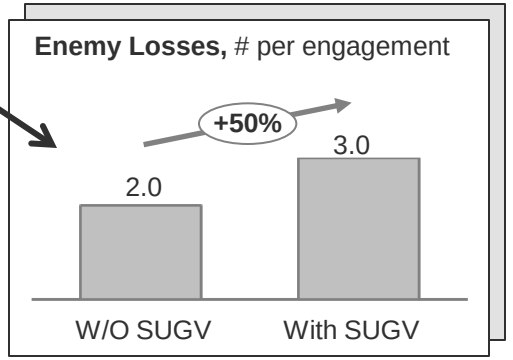
Key Benefits

- **Increased Mission Success**
  - Greater ability to engage NLOS
- **Improved Survivability**
  - Reduces friendly casualties by >50%
  - Significantly reduces IED casualties
- **Increased Lethality**
  - Increases enemy kill rate by 50%
- **Reduced Collateral Damage**

Robots provide increased SA & ability to engage NLOS, increasing mission success







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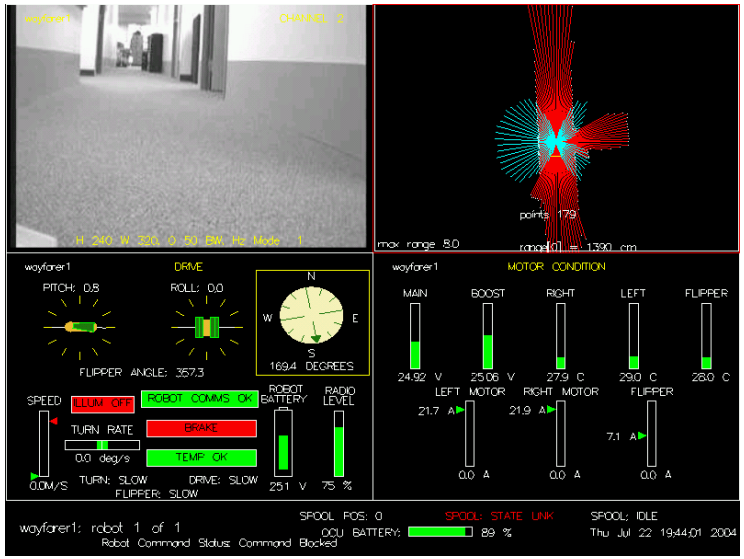
Source: Results from One Semi Automated Forces Simulator (1SAF) SIM model for SUGV tactical operations in both offensive and defensive scenarios

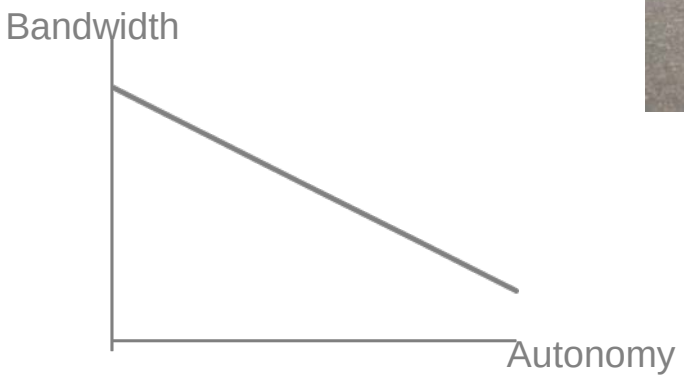
Today's Enabling Technologies

- Control via direct tele-operation.
- Sensor payloads:
  - EO/IR.
  - LIDAR.
  - Radar.
  - GPS locations.
- Game controller-based interface.
- Limited autonomy, e.g., pose control that positions arms, grippers, flippers, etc., for a particular function, e.g., stair climbing.



Sensor data collected from platform.

Example pose for looking in a vehicle.



Tele-operation requires good comms – as we progress toward autonomy, comms will be less important for tele-operation and more important for data sharing.

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Network Infrastructure & Information Sharing Capabilities

- Today's two-node (operator:robot) network.
- Multiple-node networks currently in test, but not required for robots to deliver capability today.
- Operator gets raw data from robot, e.g., speed, orientation.
- Robots require constant and detailed control from operators.
- While this works, occasionally comms limitations, e.g., bandwidth, reduce number of robots that can be simultaneously tele-operated in same area.

Today's controller and OCU.

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Next Time Horizon – Robotic Teammates

- 5+ years.
- Limited scope autonomy or semi-autonomous operations.
- Move away from dedicated operators.

Limited Scope Autonomy Makes Robots Force Multipliers

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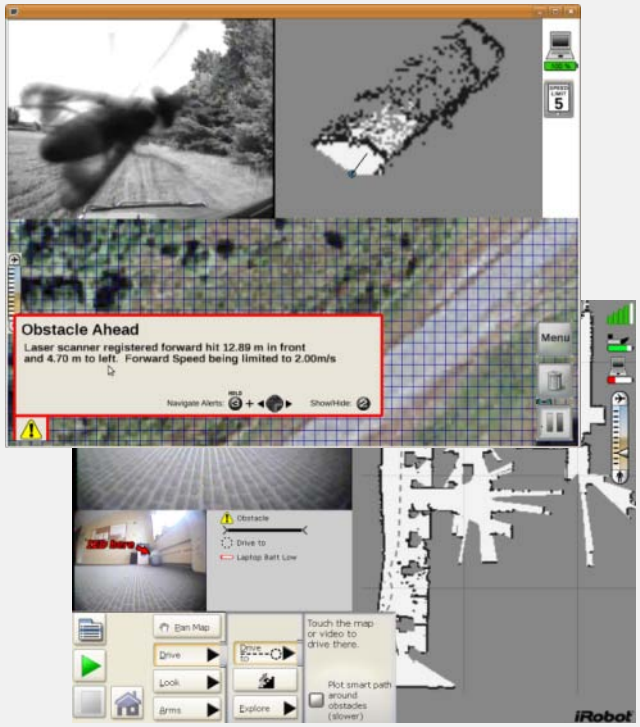
Progression and Enabling Technologies



Mapping, Localization, Navigation

Assistive Autonomy to Support Teleop

Person Following and Gesture Understanding

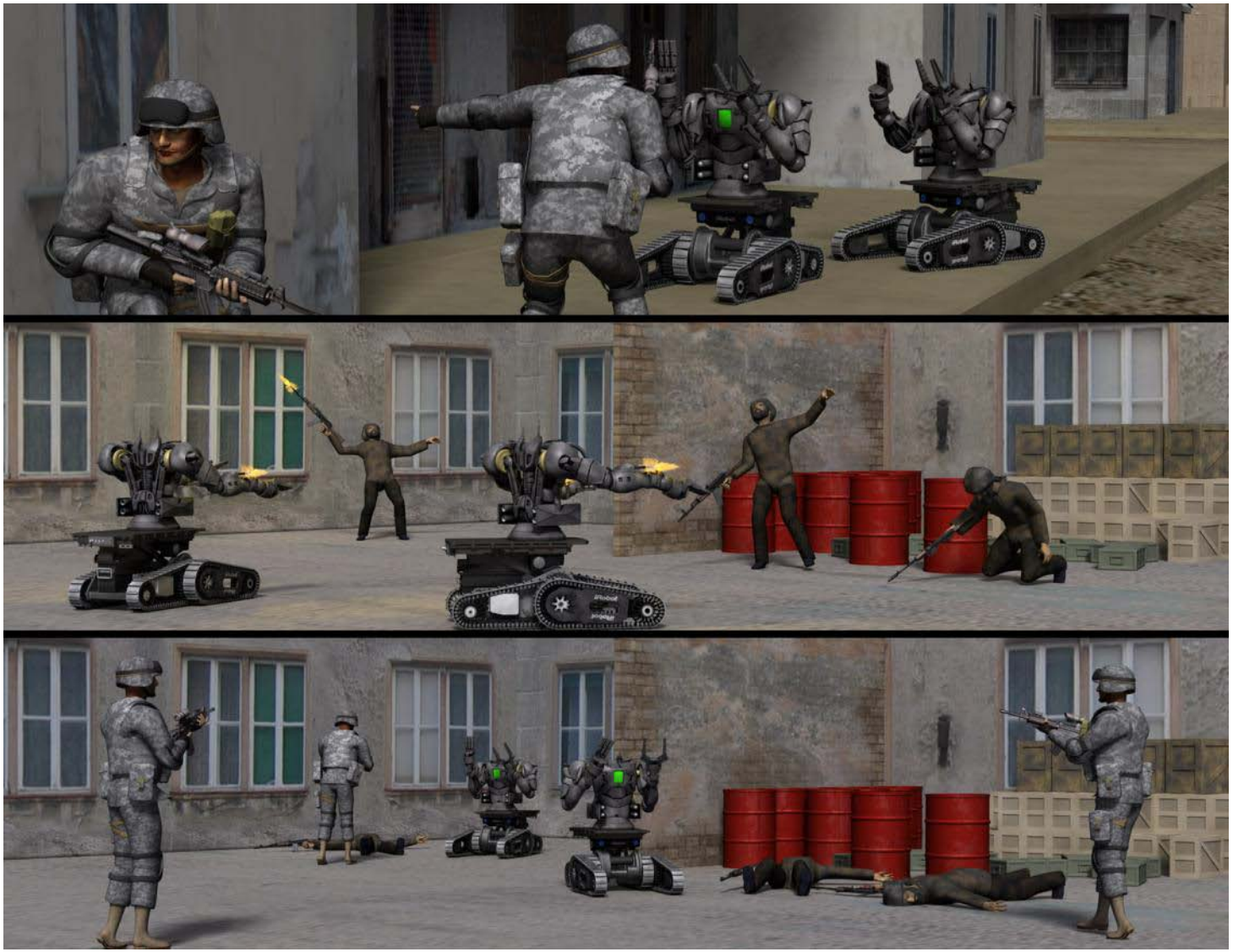
- Localization, mapping, navigation.
- Assistive autonomy.
- Natural language, gesture, and speech.
- Information sharing between humans and robots.
- Advanced power and power management.
- Encoding of basic TTPs.
- Basic team behaviors.

Fuel Cell Powered PackBot

iRobot FasTac - Camera Follows Gripper Autonomously

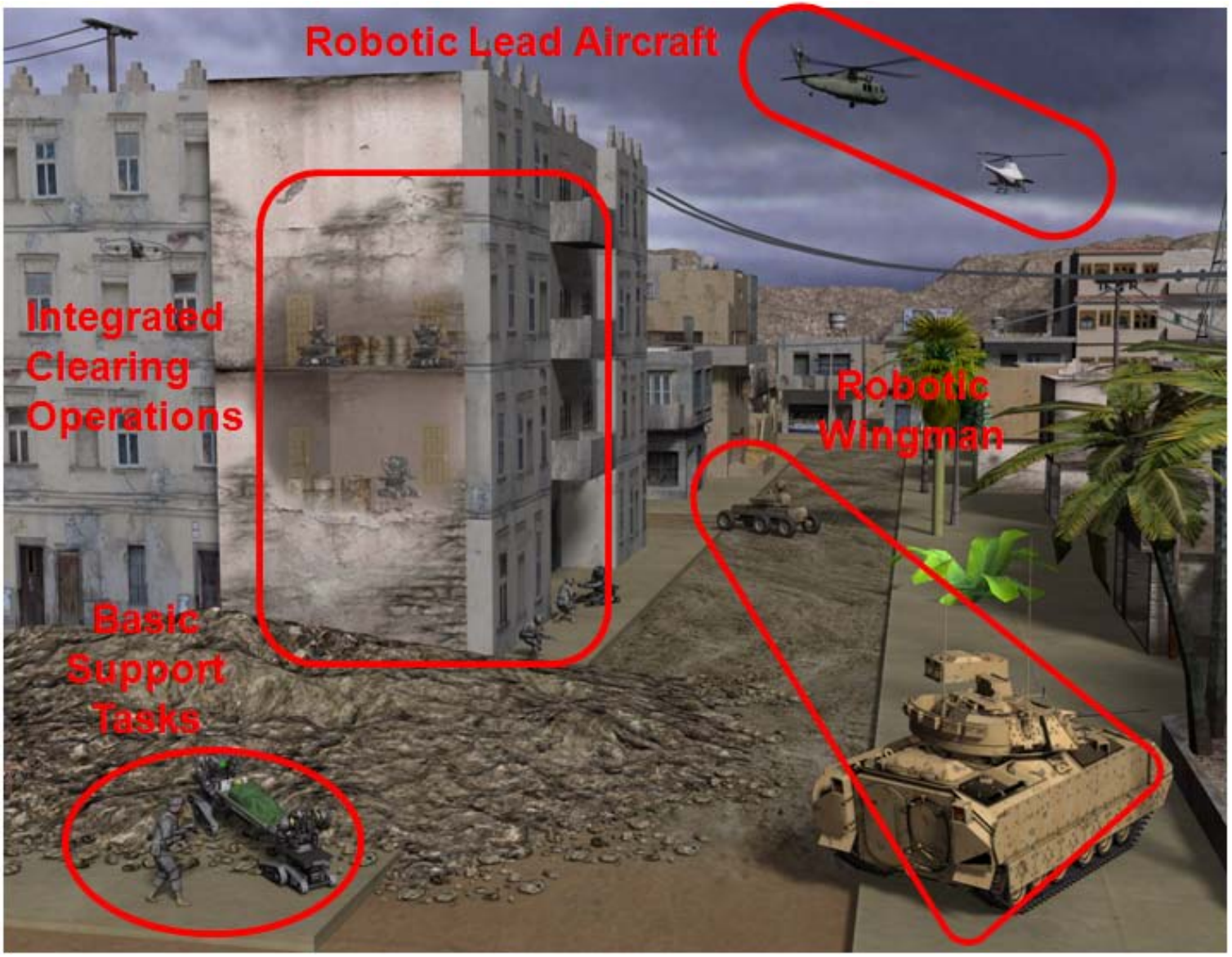
Clearing Buildings Cooperatively

- Responding to gesture and speech, executing basic TTPs. Scoped autonomy.
- Scoped Team Behaviors
- With human approval, may see force projection.
- Human warfighters still needed for assessment.



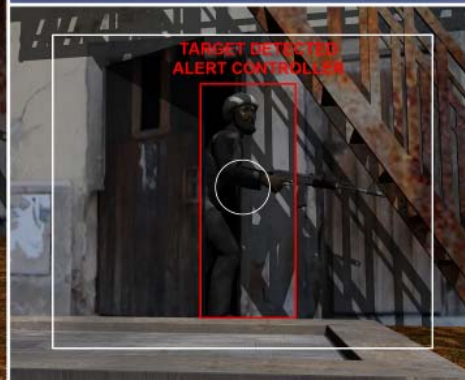
Robots Carry Out Basic TTPs – Humans Still Needed To *Understand* Situation

Robotic Teammates Will Take Many Forms



Network Infrastructure & Information Sharing Capabilities

- Ad-hoc mesh networks common place in the field – communications in urban areas, NLOS settings, etc.
- Network plus new information sharing infrastructure carries images, maps, etc., from deployed platforms back to multiple points in the field and in command.
- Via this infrastructure, when operators needed to provide direct control, one operator can guide multiple robots.
- Same infrastructure enables many different parties to act as operators – may be geographically distributed.
- Robots pre-process and filter data for the unit and team – not just passing back raw images.
- Direct UXV-to-UXV sharing.
- Performance & health monitoring.



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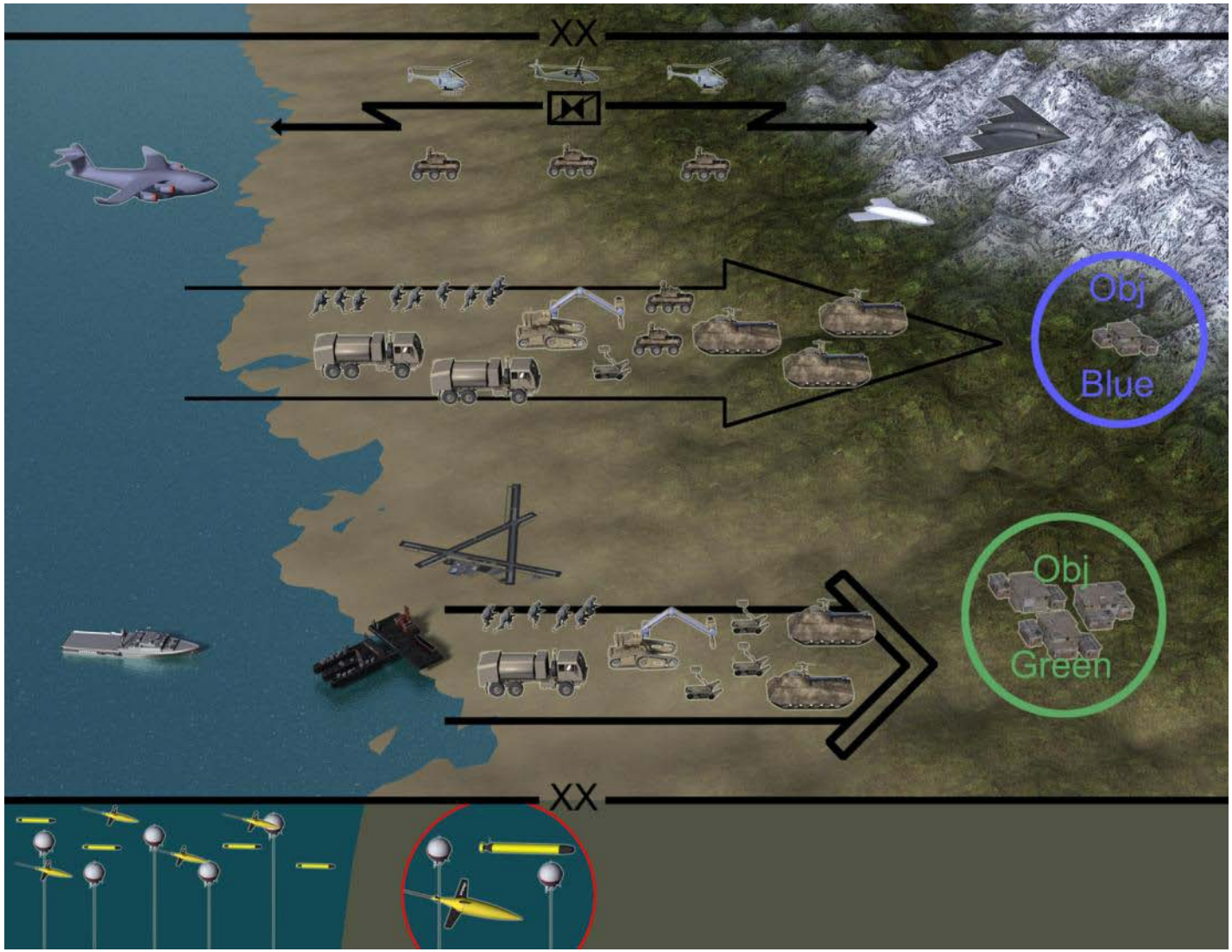
Time Horizon After Next – Robots Will Be Highly Capable, Collaborative & Connected

- 10+ years out.
- Robots will function within larger robotic organizations and integrated units.
- In parallel with commercial capability, strategic and theater transportation and logistics functions will be robotized.
- Formations will include humans and various unmanned systems.
- Heavily network dependent.



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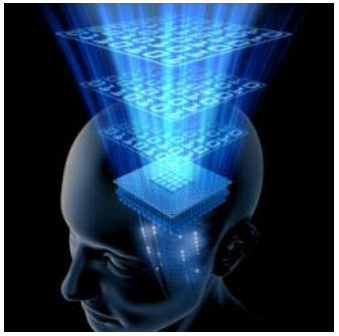
Enabling Technologies, Networks, Information Sharing

- Everything and everyone connected to the network.
- Real time sharing of information at many levels of abstraction – data, decisions, conclusions, hypothesis, etc. Human C&C will also have evolved.
- On the robots -- mission-level autonomy – not just encoding TTPs but equipping robots with ability to plan to achieve goals.
- Sophisticated perception and understanding algorithms enable robots to understand much of the world around them.
- Collective learning so robot performance improves with experience and learning is shared between robots via network.
- Long duration power sources plus power scavenging and generation.
- Combining intelligence on the robot with intelligence that is “in the network.”

Everything networked.



Sharing information at many levels of abstraction.

Smarter and more immersive C&C tools.

Robotic power scavenging.

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- **Conclusion**

Advancements Will be an Evolutionary Process

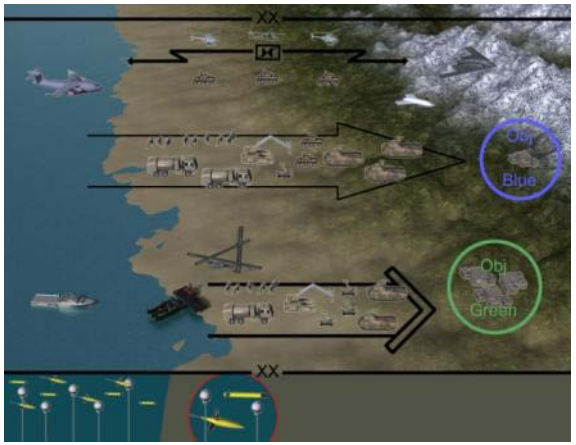
Tele-operated Robotic Tools

Today

Semi-Autonomous Robotic Teammates

5+

Autonomous Robotic Organizations



10+

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In The 5+ Year Range, Look For…

Limited Scope Autonomy, Natural Interaction With Robots, Information Sharing Beyond Raw Data, and “OMG” From The Enemy

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Thank You

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