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Applying the Goal-Question-Indicator-Metric (GQIM) Method to Perform Military Situational Analysis

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Acknowledgments

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Abstract

When developing situational awareness in support of military operations, the U.S. armed forces use a mnemonic, or memory aide, to enable planners at all echelons to provide a comprehensive analysis of the situation. The mnemonic is METT-TC, which stands for *mission, enemy, time, terrain, troops available, and civil-military considerations*. By coupling METT-TC with the goal-question-indicator-metric (GQIM) method for goal-driven measurement, military planners can develop operational resilience metrics that are mission oriented and take advantage of situational awareness. This technical note describes how to use the two methods in tandem.

1 Introduction

1.1 Purpose

Due to its unique mission, the military may find it challenging to adapt civilian-designed approaches to build situational awareness for military operational planning. This report describes a way to use a key piece of military operational planning doctrine to build operational resilience metrics via the goal-question-indicator-metric (GQIM) method.

1.2 Background

The CERT® Division of the Software Engineering Institute (SEI) conducts regular workshops to help organizations build metrics that improve their operational resilience—the ability of the organization to meet its strategic objectives during times of stress. During these "Measuring What Matters" workshops, organizations learn how to use the GQIM method to develop mission-driven, process-oriented metrics to build operational resilience. An effective resilience measurement program improves the organization's ability to meet its mission during times of stress, and the inherent stress of military operations necessitates operational resilience.

A common problem we encounter when assisting organizations with their measurement regimens is that many organizations struggle with developing metrics that provide a clearly defined payoff for the organization. Organizations often develop metrics without involving key stakeholders or considering the process the metric is intended to improve. By adapting civilian models such as GQIM to military doctrine, military planners can benefit from practices proven to be successful in other domains to avoid this pitfall. An example is the process of developing situational awareness in support of military operations. Military doctrine advises planners to perform mission analysis related to orders or plans using the METT-TC factors of *mission, enemy, time, terrain, troops available, and civil-military considerations* [U.S. Army 2012]. This report shows the relationship between METT-TC and the GQIM process for developing mission-oriented metrics to improve operational resilience.

2 The GQIM Method

The GQIM method (Figure 1) is based on work by Vic Basili and Dieter Rombach [Young 2016]. For a more detailed discussion of GQIM, see the SEI report titled *Measuring What Matters Workshop Report* [Stewart 2015].

By using the GQIM method, an organization can decompose its operational resilience needs into a set of metrics that are tied to the organization's success as a result of a given process. That is, the metrics developed quantify the capability of a process to build operational resilience.

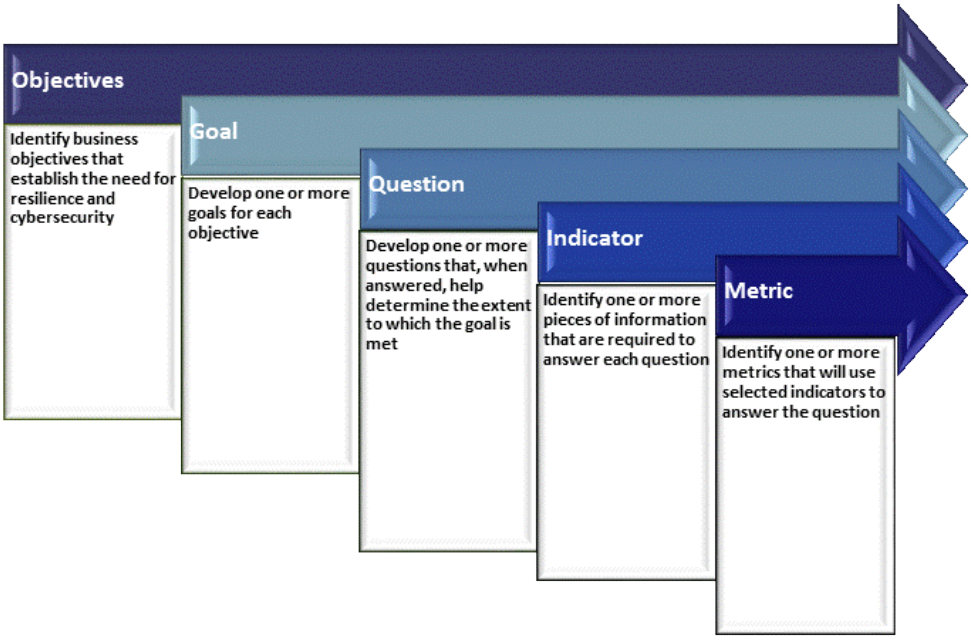

Figure 1: GQIM Method [Stewart 2015]

The following is an example of a metric that could be derived from the GQIM method:

GQIM Factor	Description
Objective (OB1)	Ensure redundant heating, ventilation, and air conditioning (HVAC) systems for each server room.
Goal (OB1.G1)	Ensure redundant heating, ventilation, and air conditioning (HVAC) systems for each server room.
Question (OB1.G1.Q1)	What are the HVAC capabilities that support our server rooms?
Indicator (OB1.G1.Q1.I1)	All server rooms.
Indicator (OB1.G1.Q1.I2)	Server rooms with multiple independent HVAC systems.
Metric (OB1.G1.Q1.I1.M1)	Percent of server rooms with multiple independent HVAC systems.

3 Mission Situational Analysis

The military advises leaders at all levels to perform situational analysis using the METT-TC factors. This type of analysis helps leaders understand situations according to mission variables. Leaders may use METT-TC when developing an order for implementation or a plan that might result in an order in the future.

The following list describes the METT-TC factors:

- *Mission.* The functions that the organization must perform. This includes the intent, or desired end state, of higher commanders; tasks that have been specified in the order or plan; and tasks that are implied through alternate guidance (such as training or doctrine) or military experience.
- *Enemy.* The intentions and capabilities of the adversary.
- *Time.* The time the action is expected to start and finish, and the time available to complete the mission.
- *Terrain.* Environmental conditions, such as topography, hydrography, and meteorology.
- *Troops Available.* The assets available to the organization performing the mission.
- *Civil-Military Considerations.* Matters regarding non-combatants, such as host nations and those affected by military operations.

4 Using METT-TC to Develop Metrics Through the GQIM Method

A military organization can use METT-TC to facilitate development of mission-oriented metrics. First, extract objectives and goals from the mission, and collect other information from the order or plan, such as the commander's intent, tasks for subordinate units, service and support (logistics), and command and control (communications). Some of these objectives may be specified in the order or plan, while others may be implied.

Next, consider enemy, time, terrain, troops available, and civil-military considerations. These factors will inform questions, indicators, and metrics by describing how well the organization will be able to meet the mission as the planner reviews the specified and implied tasks that are now broken down into objectives and goals.

The following example uses METT-TC in tandem with GQIM.

GQIM Factor	METT-TC Factor	Description
Objective (OB1)	Mission	Prepare for, identify, and defeat enemy cyber-attacks on systems that provide situational awareness of friendly force location and disposition.
Goal (OB1.G1)	Mission	Operate sensors that detect anomalous activity directed toward systems that provide situational awareness of friendly force location and disposition.
Question (OB1.G1.Q1)	Troops Available	What assets do we have to detect anomalous activity directed toward systems that provide situational awareness of friendly force location and disposition?
Indicator (OB1.G1.Q1.I1)	Troops Available	Sensor assets currently deployed on the network.
Indicator (OB1.G1.Q1.I2)	Time	Incident data with date/time during the last exercise.
Indicator (OB1.G1.Q1.I3)	Time	Transaction log data with date/time during the last exercise.
Indicator (OB1.G1.Q1.I4)	Enemy	Opposing force (also known as red teams or penetration testers) employed during the last exercise.
Indicator (OB1.G1.Q1.I5)	Terrain	Network supporting systems that provide situational awareness of friendly force location and disposition used during the exercise. If the organization used a different network than its operational network, it would be useful to also capture what is different between the exercise network and the operational network.
Metric (OB1.G1.Q1.I1.M1)	Time	Average time to report the incident from the date/time activity was first seen on the sensor during the last exercise.

Civil-military considerations may include things like the effects of the attack on the host nation's critical infrastructure (e.g., power generation, hospitals, civilian network assets involved in the attack). This consideration was not included above for simplicity.

By using METT-TC, the military planner can create a metric that lets the command know how soon they can expect to detect an attack after it begins. With the addition of the type of sensor as a

GQIM indicator, the planner can also build a metric that shows which types of sensors were most instrumental in detecting the attack. If the organization runs multiple exercises and captures this same metric each time, planners will be able to see if the organization is improving or getting worse. By applying the metric to the detection process, the organization can diagnose what positive root causes may be helping the organization to improve, or what negative root causes are making the organization's capabilities degrade. If the organization is improving, it can share the lesson learned. If the organization's capabilities are degrading, it can target and correct the root cause.

5 Conclusion

Military planners and decision makers have the same needs as civilian operational resilience practitioners for developing methods to measure their ability to achieve their mission. The GQIM method is one framework that can be adapted to existing military doctrine to enable the armed services to develop operational resilience metrics. By using METT-TC factors to populate objectives, goals, questions, indicators, and metrics, military planners can build a powerful set of metrics that can be updated as the situation changes.

References/Bibliography

URLs are valid as of the publication date of this document.

[Stewart 2015]
Stewart, Katie; Allen, Julia; Valdez, Michelle; & Young, Lisa. *Measuring What Matters Workshop Report*. CMU/SEI-2015-TN-002. Software Engineering Institute, Carnegie Mellon University. 2015. http://resources.sei.cmu.edu/library/asset-view.cfm?AssetID=433515

[U.S. Army 2012]
U.S. Army. *Army Doctrine Publication 5-0, The Operations Process*. 2015. http://armypubs.army.mil/doctrine/DR_pubs/dr_a/pdf/adp5_0.pdf

[Young 2016]
Young, Lisa. *Presentation: Measuring What Matters* (RSA Conference 2016). Software Engineering Institute, Carnegie Mellon University. 2016. http://resources.sei.cmu.edu/library/asset-view.cfm?assetid=451184

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