MODELING MISSION SYSTEM AND ENABLING SYSTEM OPERATIONS

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14th Feb

Understanding Logical and Physical Interfaces

- Who interacts with whom?
- What is exchanged, transferred, and translated?
- When does the transference or translation occur?
- Under what conditions?
- What are the expected results?

Logical interfaces establish associative relationships with performance-based outcomes (e.g., *what* is to be achieved). Physical interfaces establish *how* a logical interface will be implemented.

System Interfaces

- Provide the mechanism for *point-to-point* connectivity. We characterize interface connectivity at two levels: (1) *logical* and (2) *physical*.
- **Logical interfaces**—Represent a direct or indirect association or relationship between two entities. Logical interfaces establish:

1. Who (Point A) communicates with whom (Point B).
2. Under what scenarios and conditions the communications occur.
3. When and where the communications occur.

Example

- The Internet provides a mechanism for a User such as a computer equipped with the appropriate hardware and software to communicate with an external Web site. In this context, a _______ interface or association exists between the User and the Web sit. While the computer is _______ connected via fiber optics, landlines, satellite connections, and so forth.

system behavioral model

Six behavioral interaction models that illustrate common type of system interaction models:

1. Open loop and closed loop C2 systems,
2. Peer-to-peer data
3. Exchange interactions,
4. Status and health broadcast interactions,
5. Issue arbitration and resolution,
6. Hostile encounter interactions.

System Responses Principle

- Every system responds to stimuli, excitations, and cues in its Operating Environment with behavioral actions, products, by-products, services, or combinations thereof.

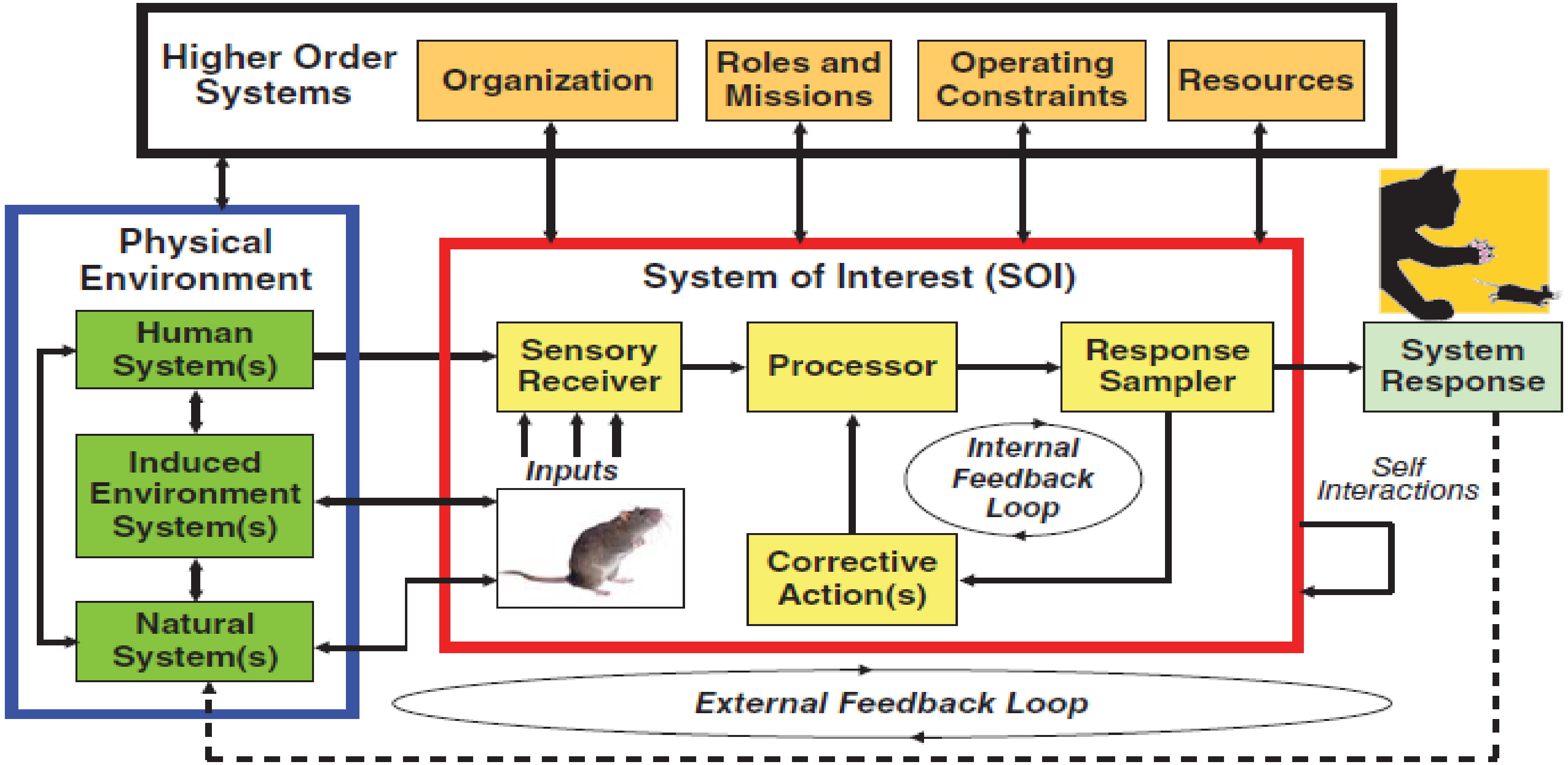


Figure 10.1 System Behavioral Responses Model

SYSTEM COMMAND & CONTROL (C2) INTERACTION CONSTRUCTS

- Open Loop Command Interactions Construct
- Closed Loop C2 Interactions

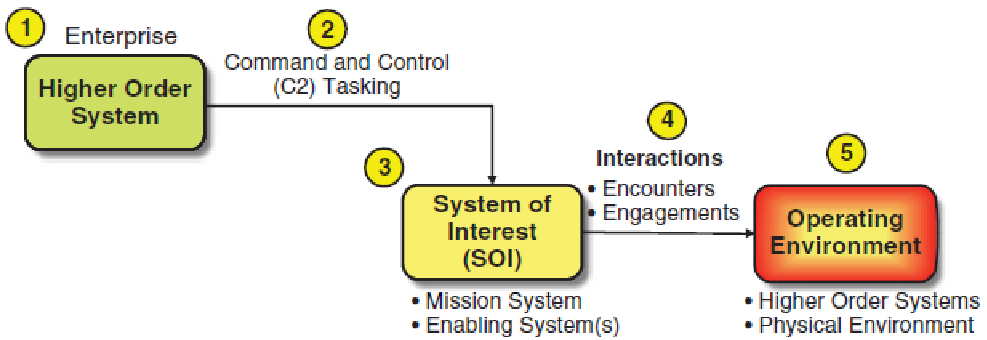


Figure 10.2 Open Loop C2 System Examples

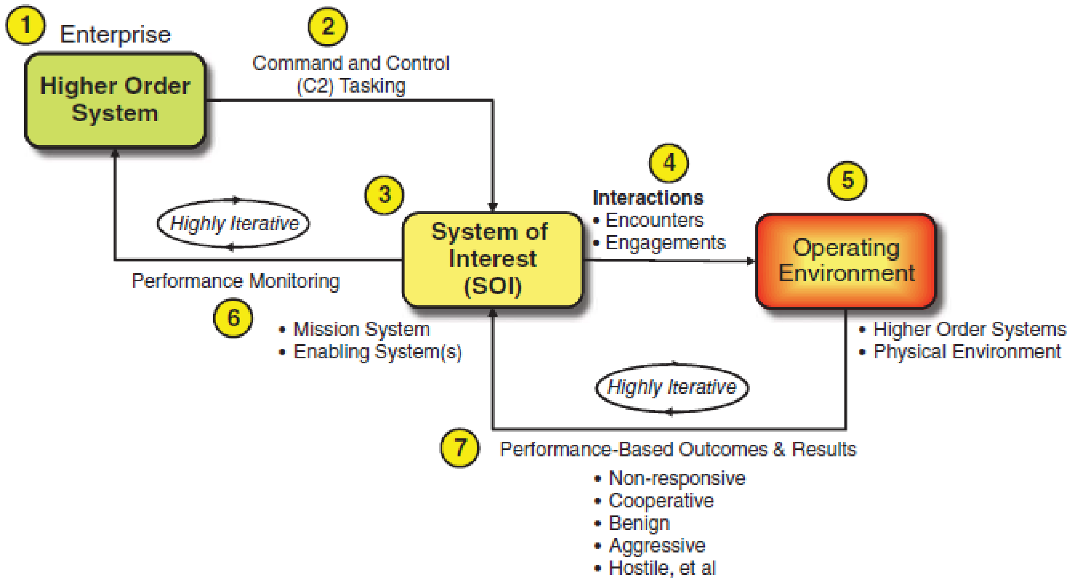


Figure 10.3 Closed Loop C2 System Examples

Personnel-Equipment Situational Assessment
Part of Monitoring, Command, and Control (MC2) requires continuous updates that present Situational Assessment of (1) system performance, and OS&H status and (2) Operating Environment conditions.
The User – operator or maintainer – has a "need to know" Situational Assessment from the Equipment to perform their mission tasking.
Likewise, the Equipment's internal MC2 requires Situational Assessment information from Subsystem Assembly, Subassembly components such as sensors to report to the User.

Remote Broadcast Weather System
Remote weather collection systems (SOIs) are installed in the vicinity of an airport to transmit *synchronous* weather data 24 hours per day and 7 days per week at a 1 Hz rate to a Higher Order System at the airport for processing and dissemination to aircraft.

Peer-to-Peer Data Exchange System Interactions

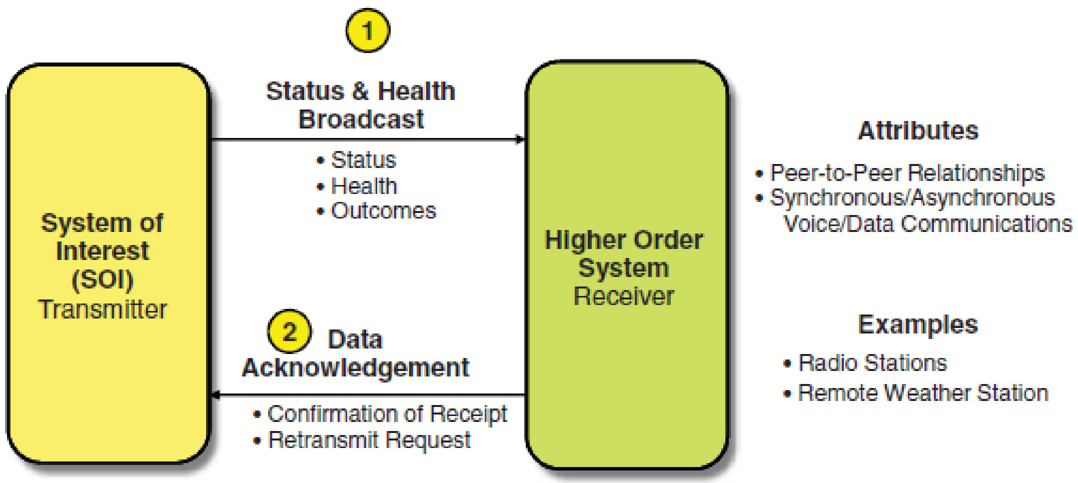


Figure 10.4 Status and Health Broadcast System Interactions Example

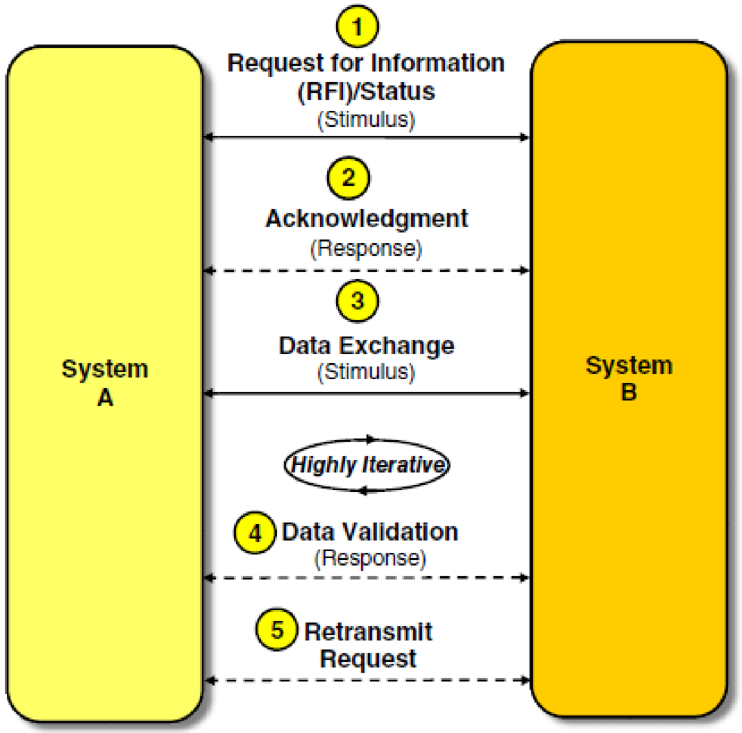
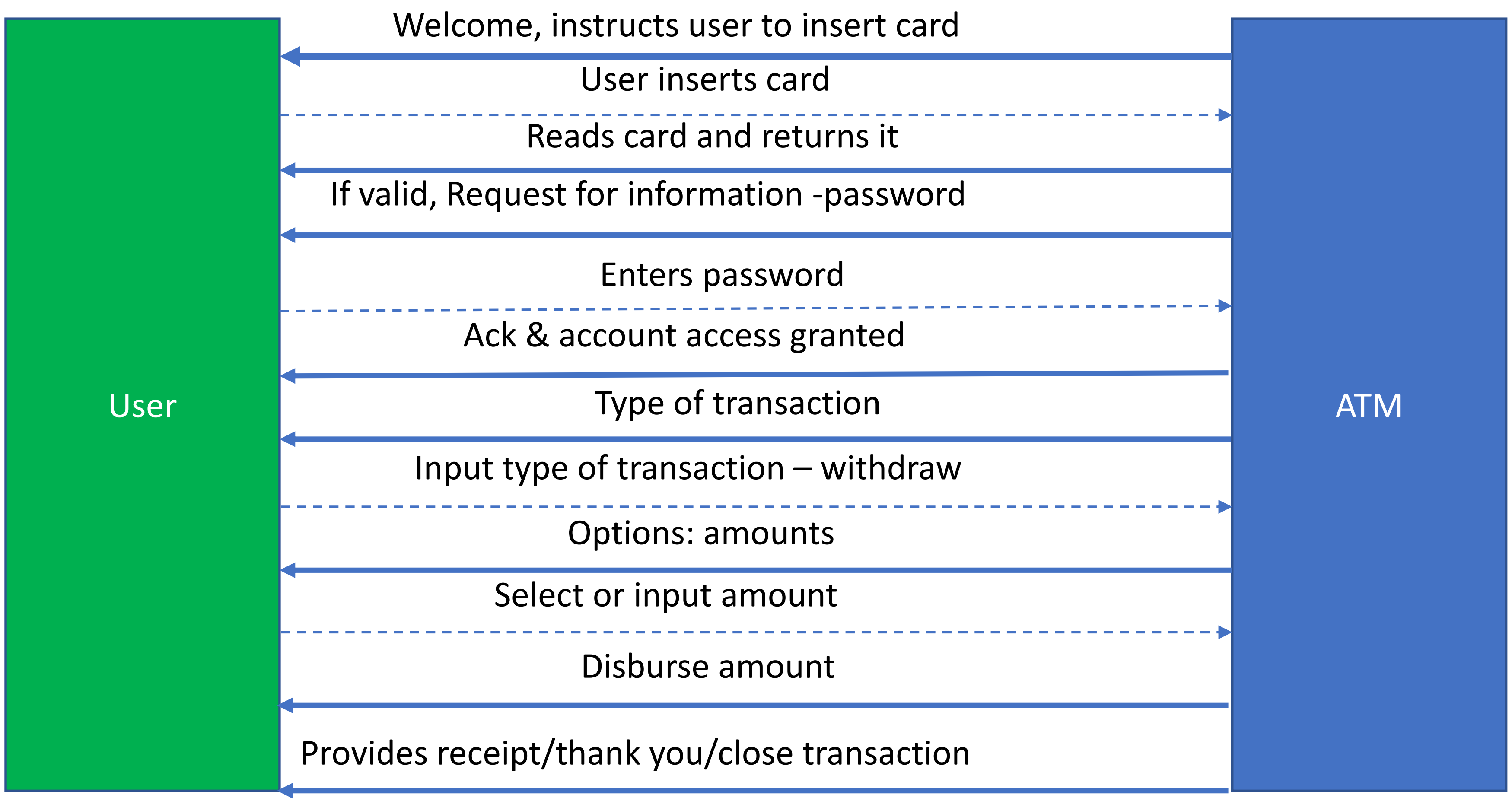


Figure 10.5 Peer-to-Peer Data Exchange Interactions Construct

Bank Card Transaction Example

A bank card User arrives at an Automated Teller Machine (ATM) location. The ATM displays a welcome and instructs the User to insert their card into the ATM. The ATM reads the card information and returns it to the User. If the account is valid, the ATM issues a Request for Information (RFI) to the User to enter a password to access account information.

Peer-to-peer interaction -example



Arbitration/Resolution System Interactions Construct

Hostile Encounter Interactions Construct

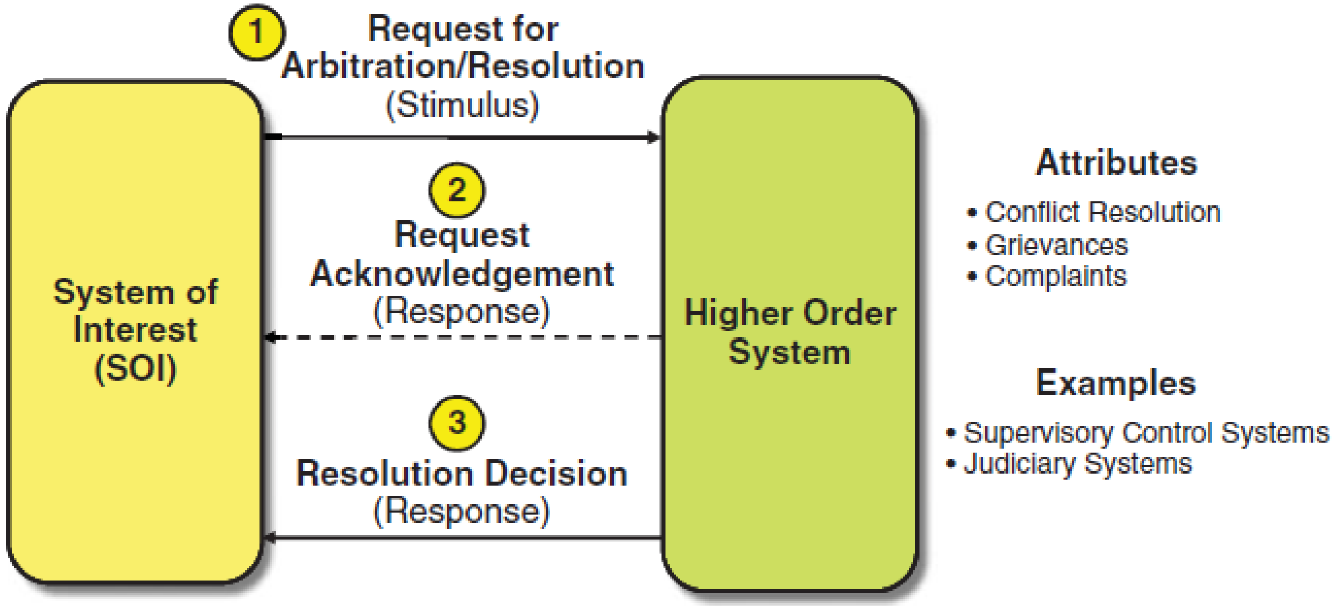


Figure 10.6 Issue Arbitration/Resolution System Interactions Construct

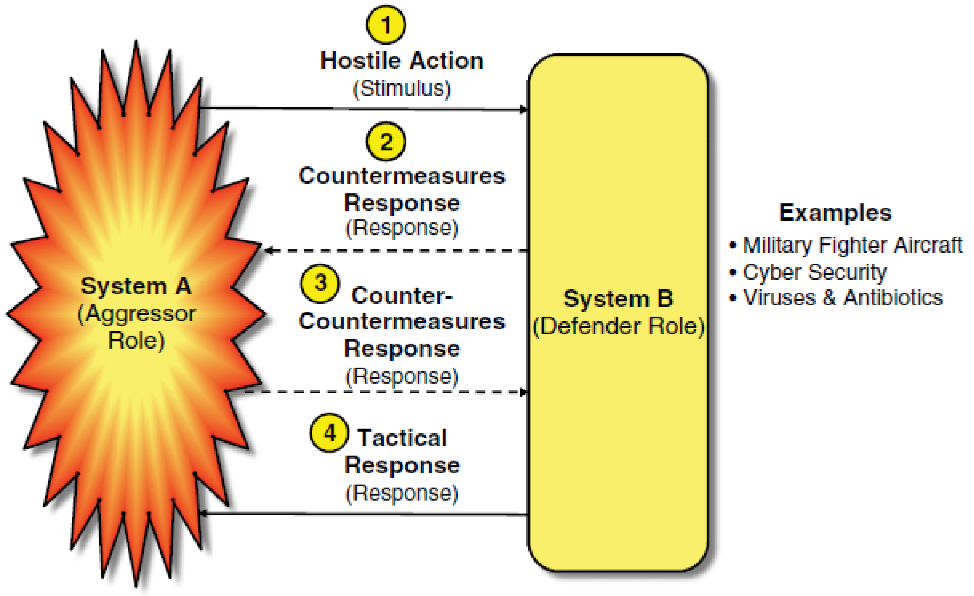


Figure 10.7 Hostile Encounter Interactions Construct

Examples: arbitrations in trade, conflicting from 2 statistical analyses – who makes the final decision?

merchandise may be
replenished,
moved

Clean-up & record update

- *Control flow or workflow* enables us to understand *how* system operations are sequenced.

- *Data flows* enable us to model information, data, or energy exchanges between system entities such as electrical, optical, or mechanical.

Store opens – personnel ready

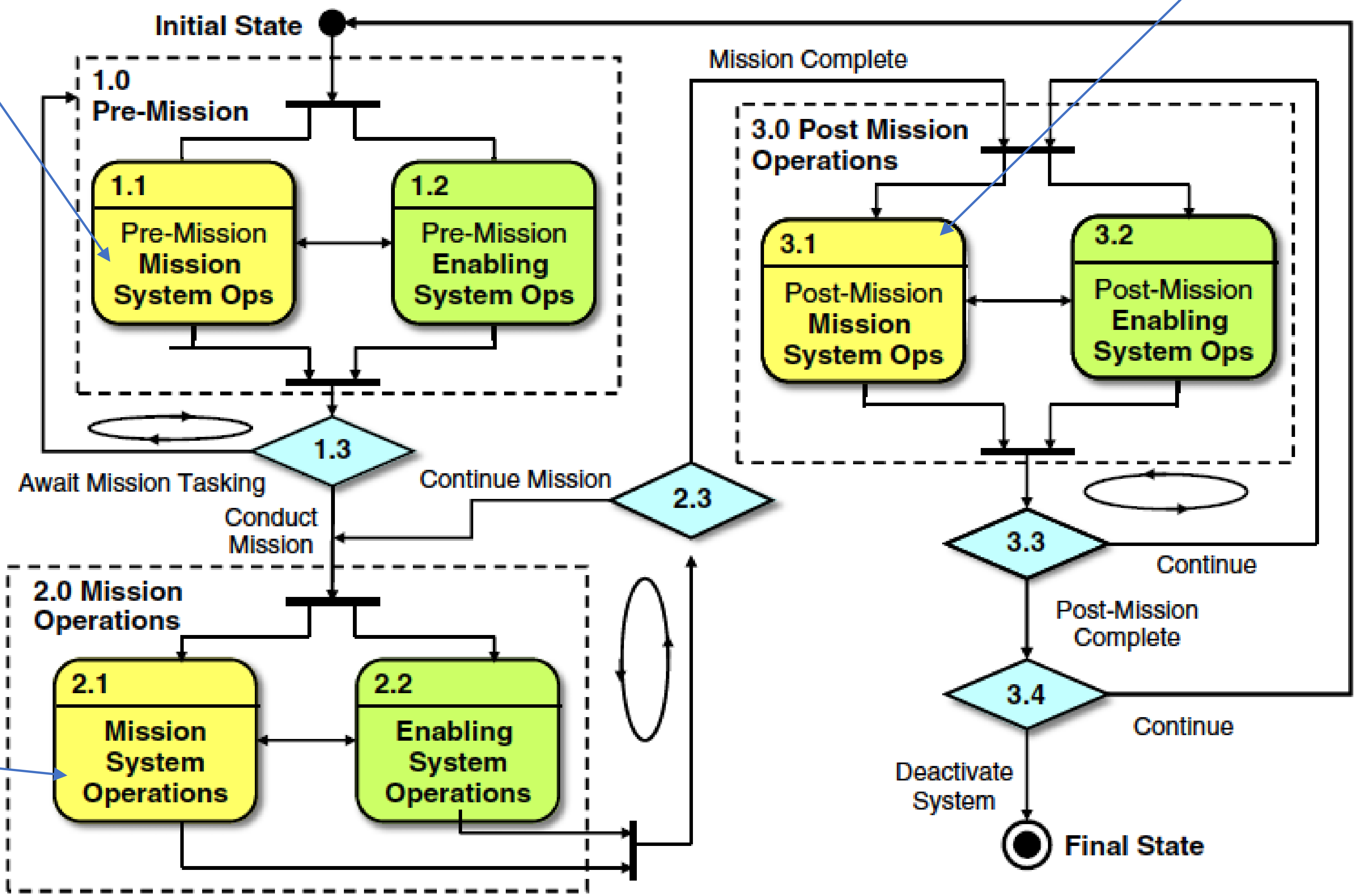


Figure 10.10 Concurrent Multi-phase Operations Model

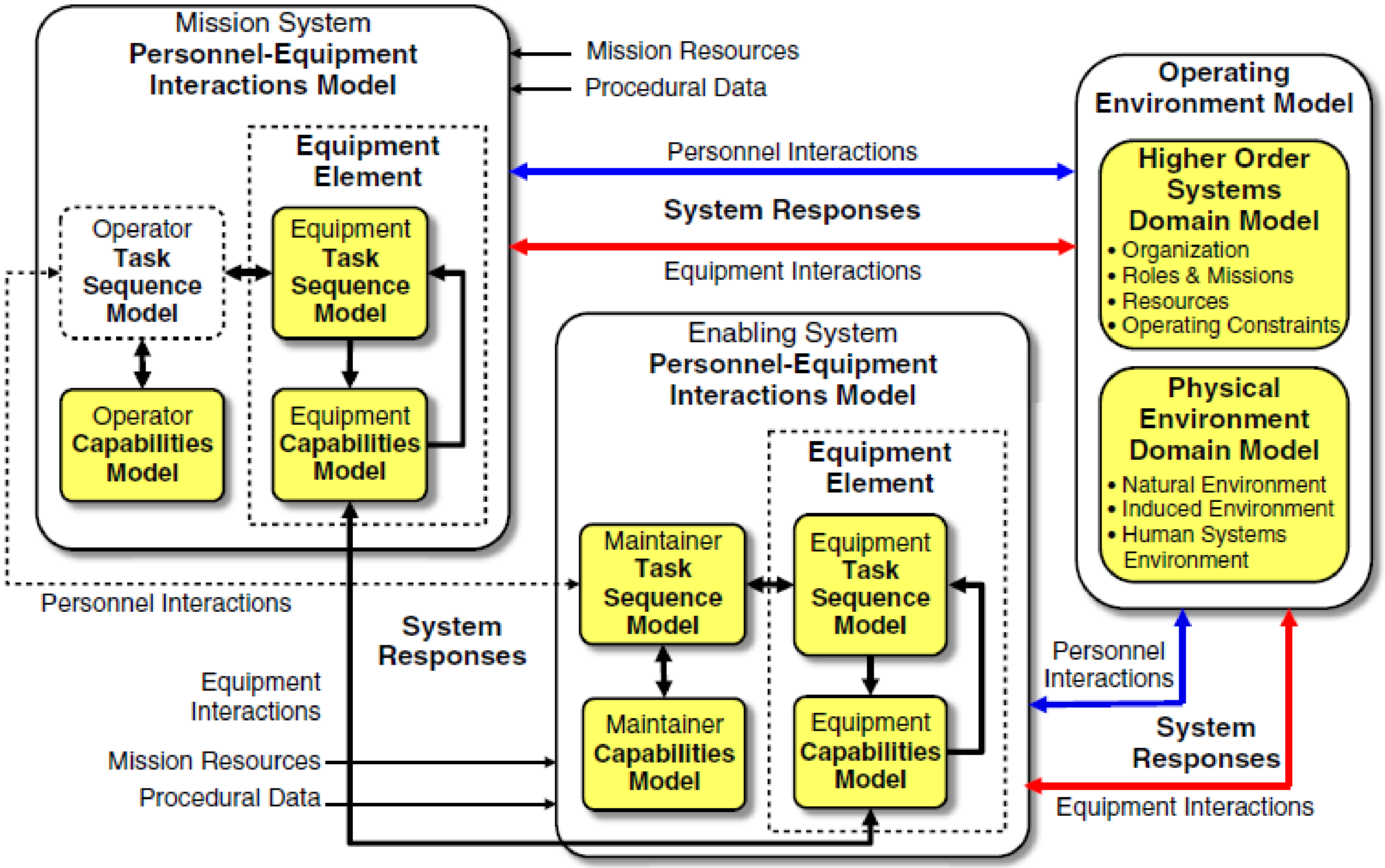


Figure 10.15 Personnel–Equipment Interactions Illustration

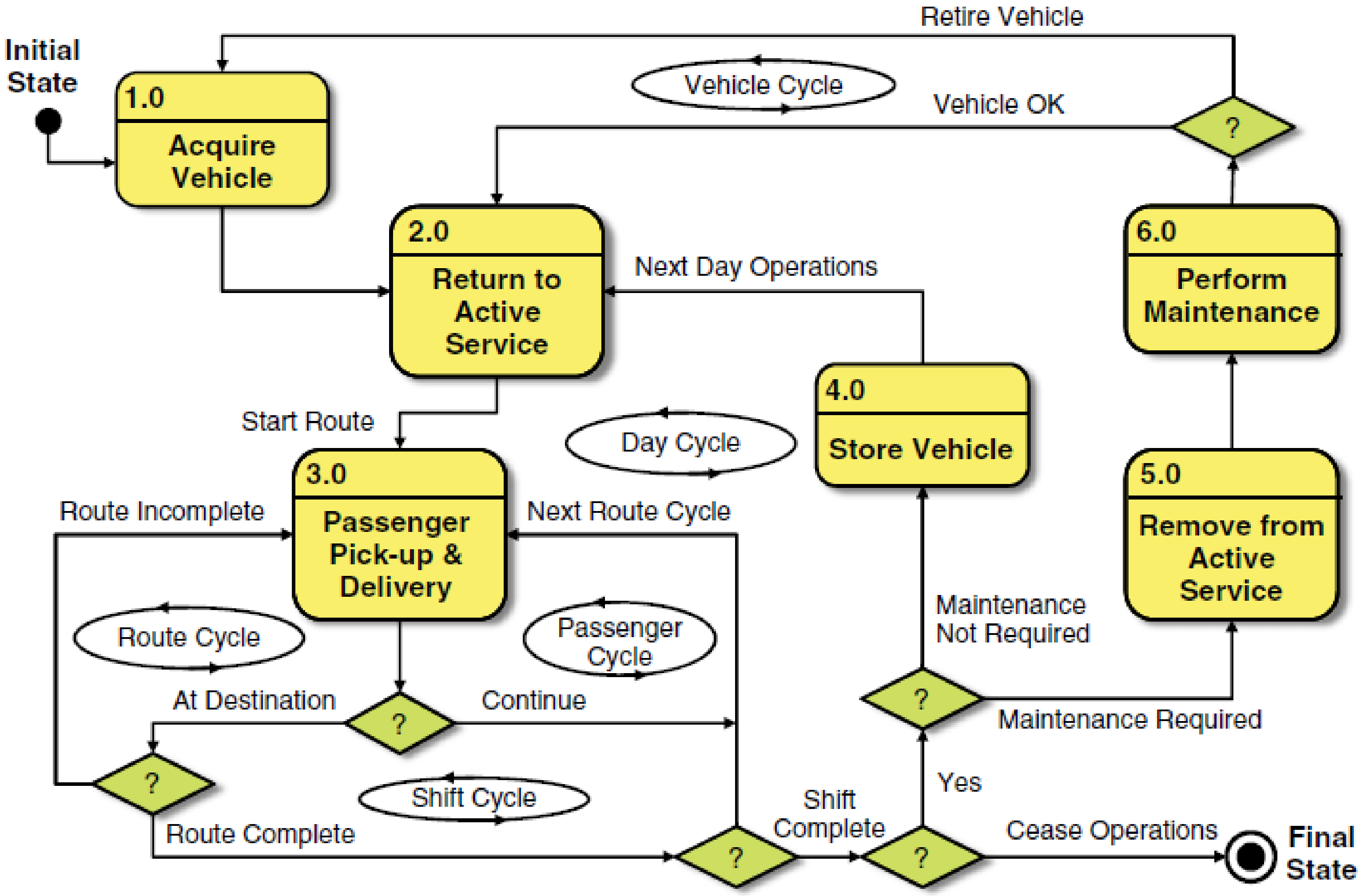


Figure 10.20 Business Operational Cycles within Cycles

The six operational cycles, which are assigned reference identifiers, include a Vehicle Life Cycle, a Daily Schedule Cycle, a Driver Shift Cycle, a Route Cycle, a Passenger Cycle, and a Maintenance Cycle

MODEL-BASED SYSTEMS ENGINEERING(MBSE)

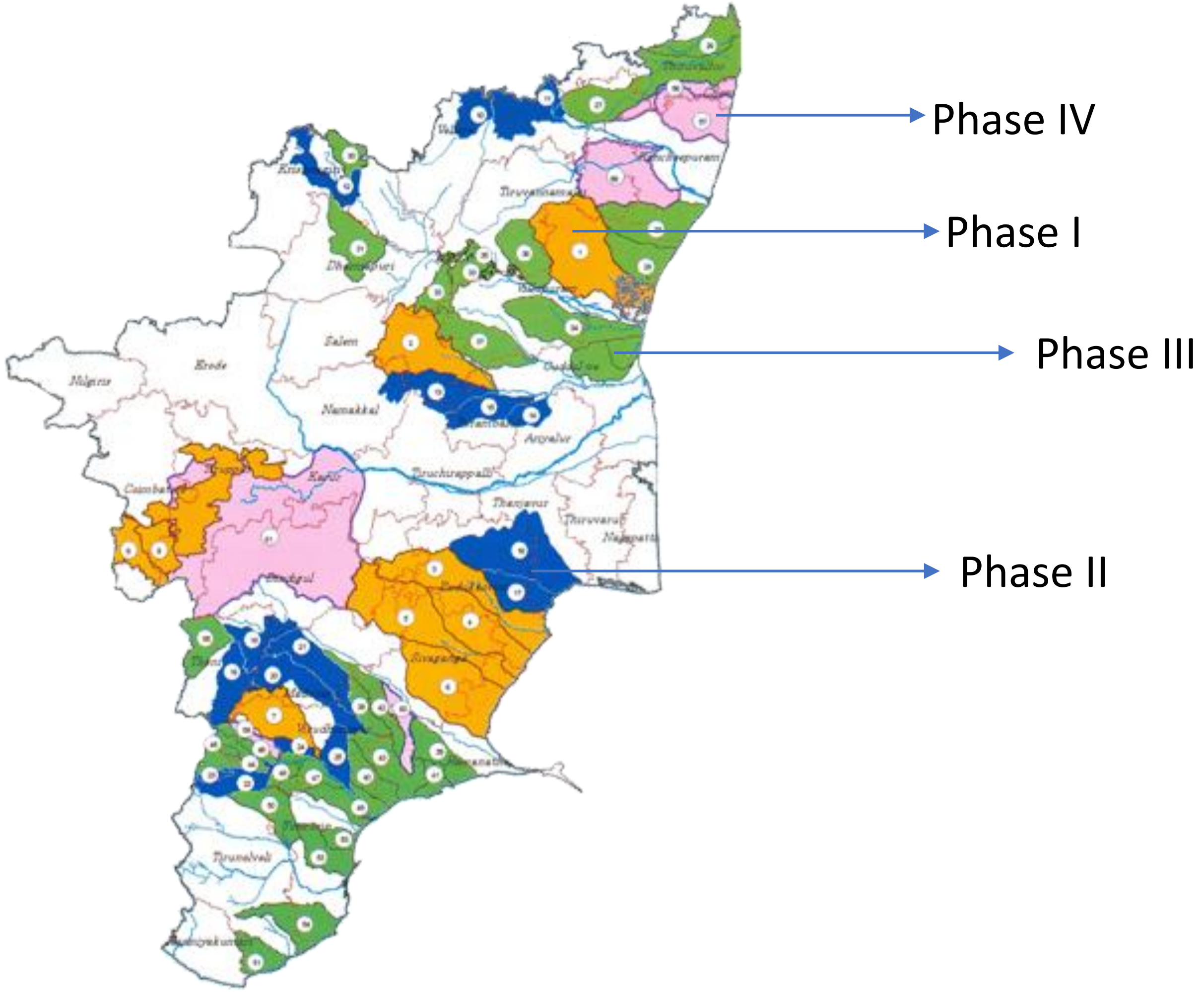
- Concepts for Modeling and Simulation (M&S) of system capabilities and performance as a means to identify, bound, and specify system capabilities; assess and resolve Critical Technical and Operational Issues (CTIs/COIs);
- Organizations began creating M&S standards in the 1980s such as the DoD.
- Needed was an universal descriptive language for characterizing systems and data standards for M&S software. As a result, work on the Universal Modeling Language (UML™) began in the 1990s at Rational Software for software intensive systems.
- In 2001, the International Council for Systems Engineering (INCOSE) began a SysMLTM Initiative to customize UML™ for SE applications.
- Subsequently, this leads to the development of Systems Modeling Language (SysML™) as a subset of UML™.
- In September 2006, the Object Management Group (OMG) released the OMGSysML™Version 1.0 as an available specification in September 2007.
- tool vendors began development and certification of MBSE tools to the OMG UML™ and SysML™ standards

In Summary

- A system’s responses are driven by strategic and tactical interactions related to opportunities and threats in the environment. Systems generally interact with cooperative, benign, competitive, or aggressor systems.
- Based on those responses, we indicated how a system might employ countermeasures and counter-countermeasures to distract, confuse, defend or interact with other systems.

Case Study - Irrigated Agriculture Modernization and Water-Bodies Restoration and Management

- Tamil Nadu is one of the driest states in India, averaging only 925 millimeters of rainfall a year. Per capita availability of water resources in Tamil Nadu (Population about 62 million) is only 900 cubic meters a year, compared with 2,200 cubic meters for all of India.
- Tamil Nadu’s geographic area can be grouped into 17 riverbasins, a majority of which are water-stressed. There are 61 major reservoirs, about 40,000 tanks (traditional water harvesting structures) and about 3 million wells, that heavily utilize the available surface water (17.5 BCM) and groundwater (15.3 BCM).
- Agriculture is the single largest consumer of water in the state, using 75% of the state’s water. Irrigation through a combination of canals, wells, and tanks increases the reliability and availability of water for farming and is essential for cultivating crops in much of the state.
- Approximately 30% of the net irrigated area of 3 million hectares is watered by canals and 21% by tanks, while 49% is fed by wells irrigated by other sources such as streams and springs. Rainfed agriculture, employing approximately 25% of farmers, accounts for 46% of the net sown area of 5.5 million hectares


Phase IV
Phase I
Phase III
Phase II

Case Study

- Objective: to improve irrigation service delivery and productivity of irrigated agriculture with effective integrated water resources management in a river basin/sub-basin framework in Tamil Nadu.

1) Irrigated Agriculture Modernization – is the main system (US$450 million)

Sub-systems:

a) Irrigation systems modernization in a sub-basin framework

b) Institutional Modernization for Irrigated Agriculture

c) Sustainable Agriculture modernization

2) Water Resource Management –US$50 million)

a) State-level (converting the WRCRC to a State Water Council), amalgamating the associated sub-committees and upgrading the Institute of Water Studies (IWS) and the Surface and Groundwater Data Center (SGDC) to a State Water Resources Agency, establishment of a Water Regulator.

b) Basin-level (Strengthening, empowering and expanding Basin Development and Management Boards, development of basin analytical decision support systems.

c) Water Resources Research Fund(WRRF)

The project outcome indicators

1. Percentage increase in value of crop production per unit of irrigated water supply (in comparison to without project)
2. Increase in area under micro-irrigation;
3. Increase in area under high value crops;
4. Percentage increase in targeted farmers' incomes compared to other farmers;
5. Joint preparation and implementation of sub-basin development plans across relevant implementing agencies;
6. Enhanced sustainable water resource planning capacity (targets being 3 sub-basin and 1 basin board formed).

System Effectiveness

- Strengthening of Dams and Canals
- ·Equanimity and surety of Water distribution
- ·Acceleration of production and productivity in agricultural area
- ·Acceleration and development of production and productivity in agricultural area
- Management of village tanks and Participation and strengthening of water user agencies

Risks

- .The complexity of coordination among the nine implementing agencies was correctly identified as a substantial source of risk.
- A risk of high turnover of field staff did not materialize during implementation.
- The lack of government priority for institutional reform was rightly identified as a substantial risk as evidenced by the delays in certain reforms and institutional changes at the beginning of the project.
- In hindsight, a significant shortcoming was the failure to recognize climatic disorders such as severe droughts as potential threats to the achievement of expected outcomes.
- As it turned out, severe droughts would lead to lower than expected agricultural performance in 2012 and 2013.