The Analysis of Information Exchange Capability for Battlefield Networks using M&S techniques of the NetSPIN

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Agency for Defense Development
Defense Cyber Warfare Technology Center

S. H. SHIM , J.Y. CHEON, and M.G. AHN

국방과학연구소
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Introduction

Introduction

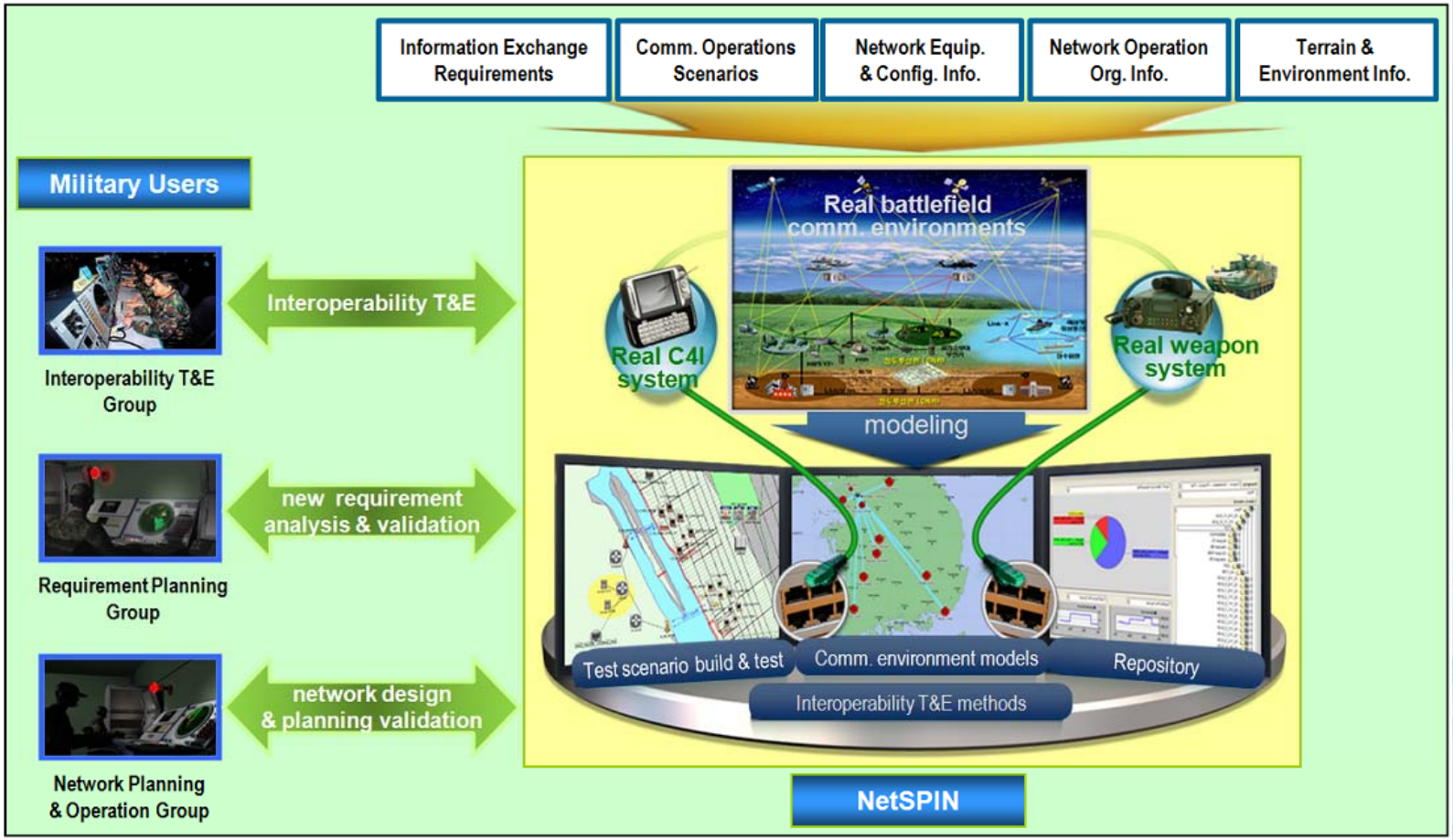
- For the Network Centric Warfare and Operations, the interoperability between C4ISR & weapon systems is essential.

- Interoperability
  - The ability of systems, units or forces to provide data, information, material and services and to accept the same from other systems, units or forces and to use the data, information, material and services so exchanged to enable them to operate effectively together.

- Especially, the timeliness and correctness of information exchange is needed as a key factor of interoperability.
  - Information exchange capability of C4ISR & weapon systems has to be validated.
  - To analyze and assess them, the network M&S techniques have been developed and utilized .
    - JCSS - DISA , NetCOS - EADS

Introduction

- NetSPIN (Network Simulator & Planner for Interoperability)
  - Tool that is able to conduct interoperability T&E by utilizing M&S of battlefield networks using the OPNET, and by interlocking the external real C4I & weapon systems
    - timeliness and correctness of information exchange



Introduction

- Introduce the analysis method of information exchange capability for battlefield networks using M&S techniques of the NetSPIN.
  - Explain NetSPIN M&S techniques
  - Analyze and evaluate the timeliness of messages for the specific operation
    - when the traffic of the SPIDER is increased due to introduction of new systems such as an UAV in a corps and a VTC system in a division.
    - the battlefield network is composed of simulated models of the SPIDER.
    - equipments and organizations of the ATCIS are modeled and interconnected on the SPIDER grid, and they communicate mutually to exchange simulated traffics.
  - Compute the end-to-end delay of operation messages and the throughputs of links
    - to assess affects for the existing battlefield network due to introduction of new systems

Network modeling of the NetSPIN

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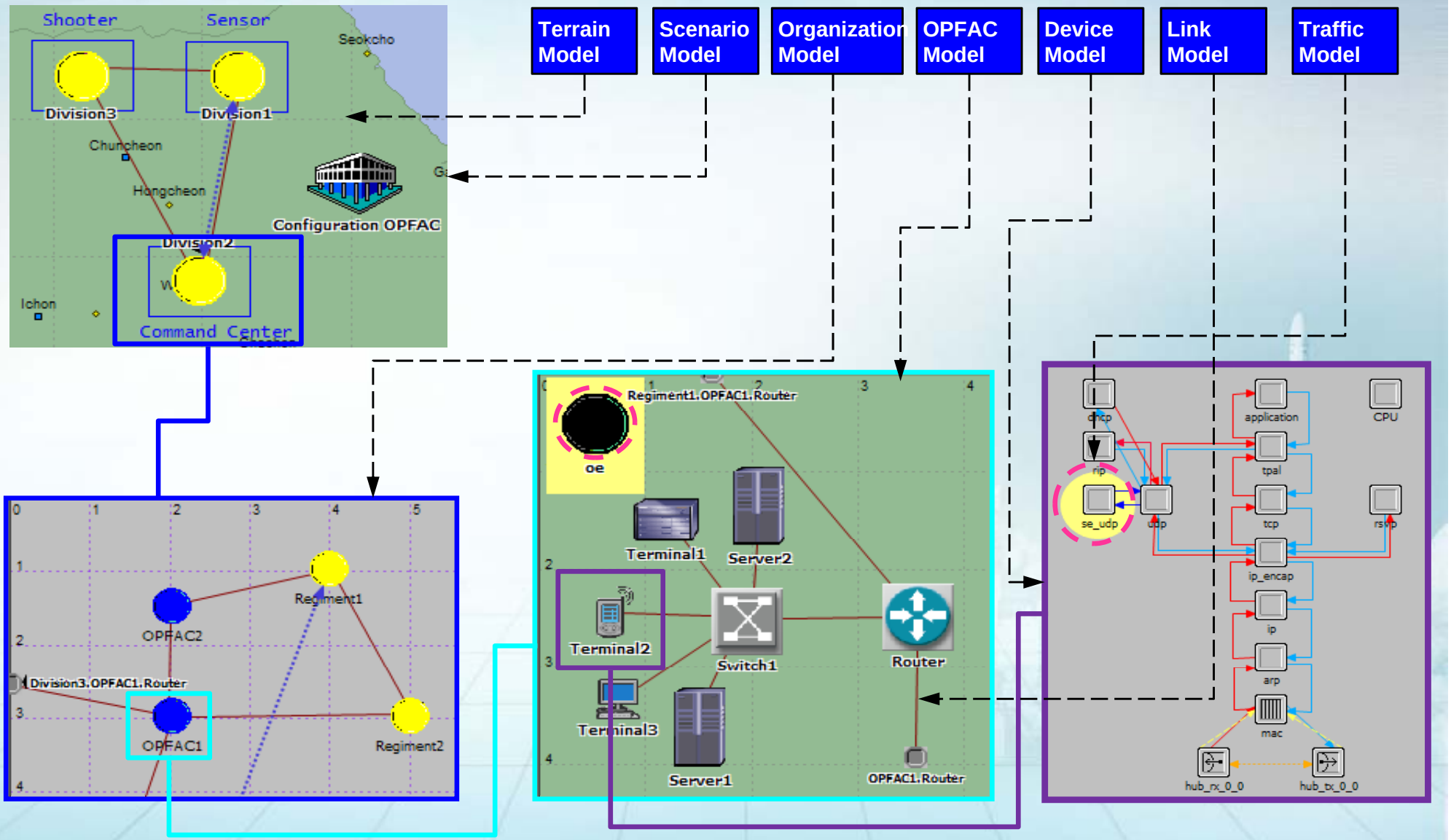
Network modeling of the NetSPIN

- Overall model hierarchy of the NetSPIN



Device modeling

- Device models of the ATCIS

Name	Main functions
Terminal	Functions as the terminal that generates traffics
MFE (Multi-Function accessing Equipment)	Function to transform messages of SST into TCP /IP packets
Terminal_PPP	Functions of the terminal as the commander's laptop to access the ATCIS in the battalion under the direct control of the regiment
DMC (Digital Modem Concentrator)	Function to serve PPP (Point to Point Protocol) services in the battalion under the direct control of the regiment
DLP (Data Link Processor)	Function to transmit data between functional centers and units
ATCIS_SERVER	Functions of the server for data requests between a functional room and a unit
SST (Surveillance & striking System Terminal)	Functions to generate, transmit, and receive traffics
Backbone switching hub	Functions for L2 switching
Workgroup switching hub	Functions for L2 switching

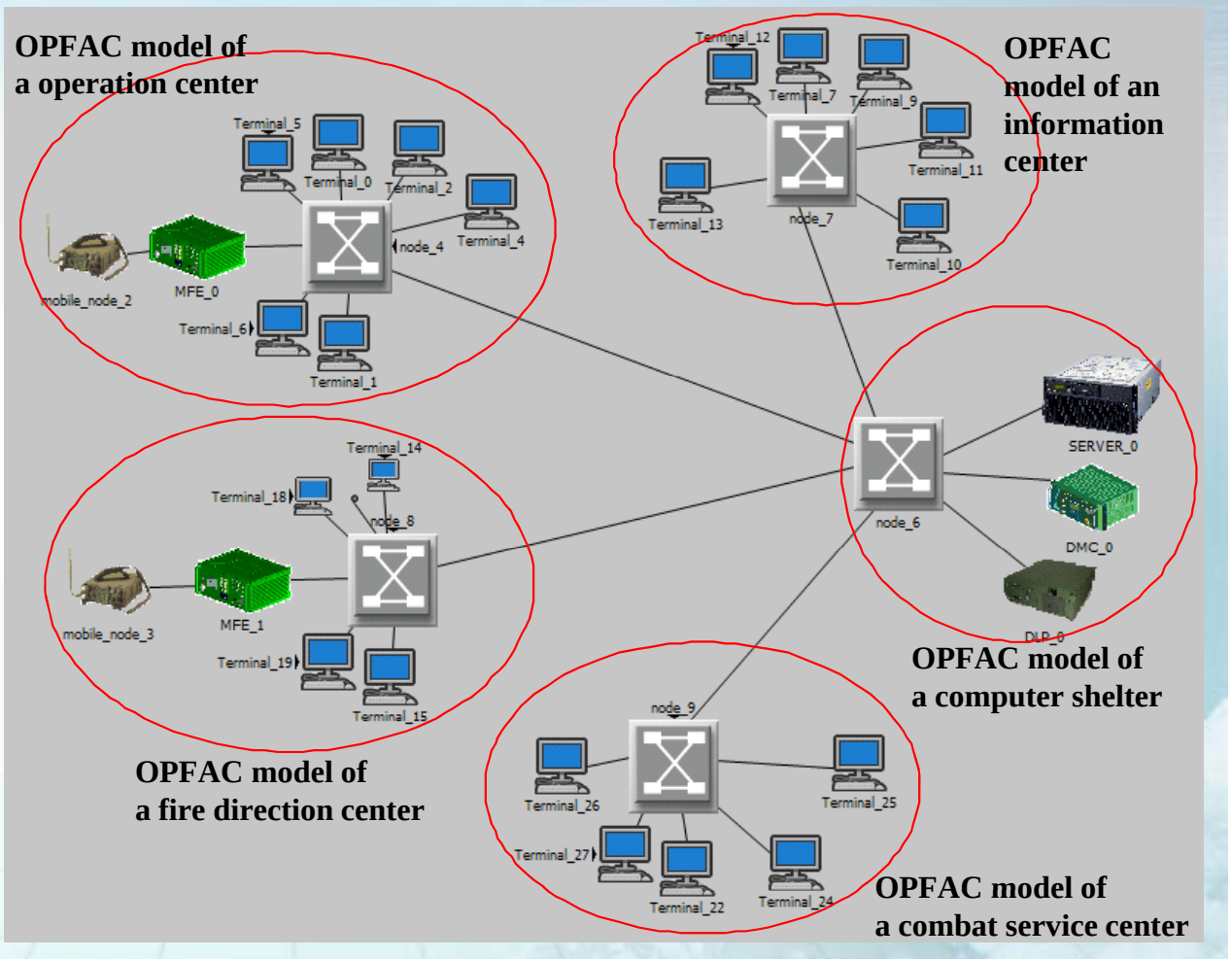
Device modeling

- Device models of the SPIDER

Type	Name	Main functions
Circuit-based switch	TTC-95K (Tactical Switch)	· call processing · circuit switching · flood search routing for searching the position of subscribers · resource management
	PCU (Packet Communication Unit)	
	RSC (Remote Subscriber Concentrator)	
IP router	TDU (Trunk Distribution Unit)	· IP routing function · Integrated multiplexed trunk operation
Mobile communication device	RAU (Radio Access Unit)	· circuit switching · wireless accessing function
	MST (Mobile Subscriber Terminal)	· call processing and data communication function · wireless accessing function
Wireless transmission device	TMR (Tactical Multichannel Radio)	· wireless relay function · wireless accessing function
	RLI (Radio Link Interface)	
Terminal	DMT (Digital Multi-role Terminal)	· call processing · data communication function
	CNRI (Combat Net Radio Interface)	· call processing · interconnection with a FM radio

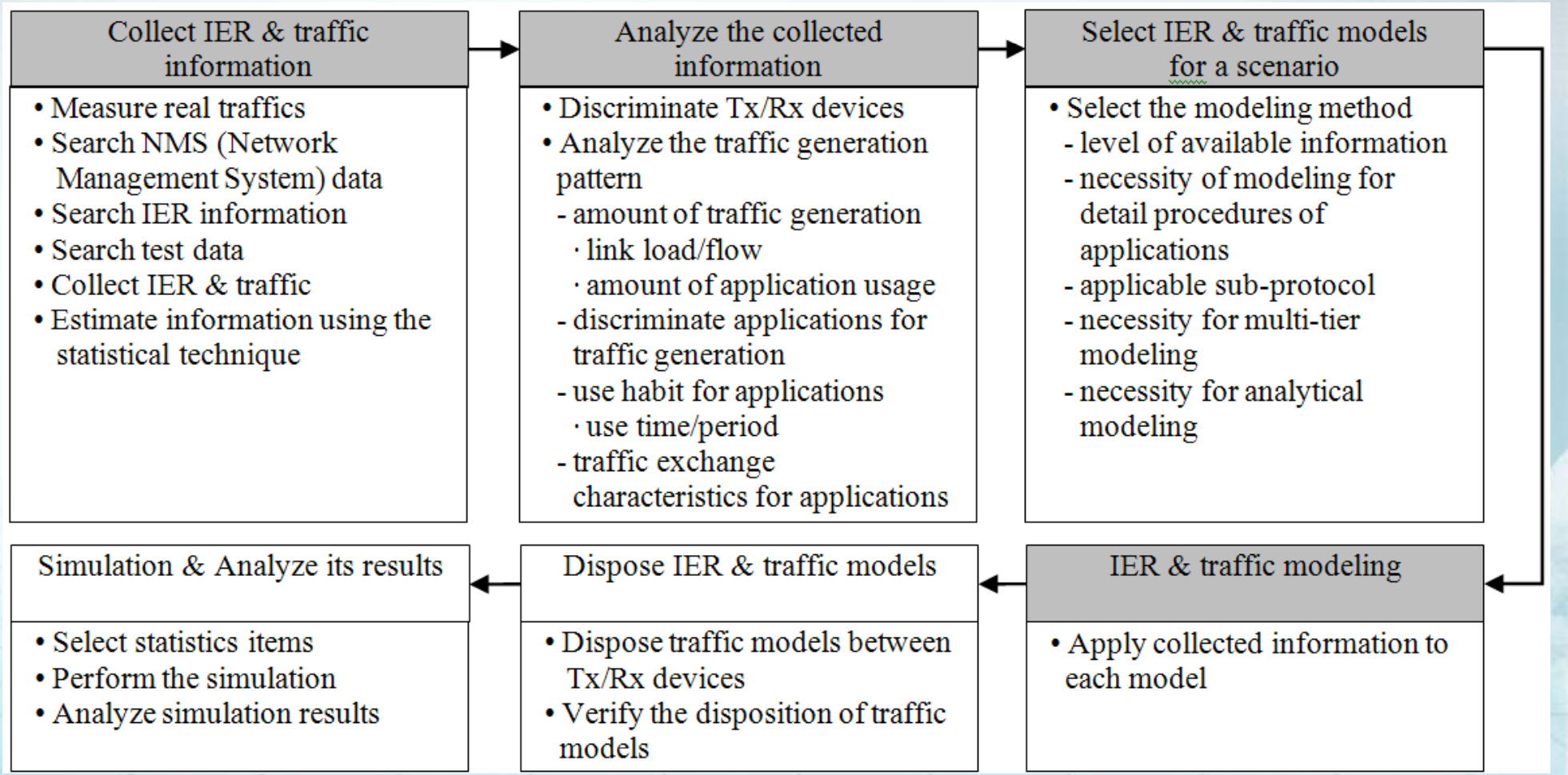
OPFAC and organization modeling

- OPFAC model
  - simulates the set of communication devices that are grouped according to the system type and the military organization
- Organization model
  - simulates a military organization
  - is the hierarchical combination set of OPFAC models
  - include subordinate OPFAC models



Traffic modeling

- NetSPIN uses several traffic models
  - **IER** / **thread** / application / application demand / traffic flow models
- Modeling procedure of IER and traffic in overall simulation process



Scenario modeling and simulation

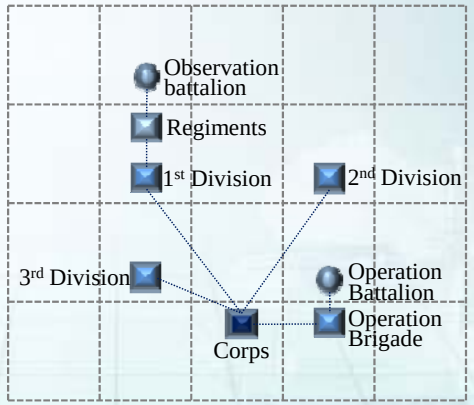
Scenario modeling and simulation

- Scenario concept for the analysis of information exchange capability
  - In the composition of our simulation scenario, a corps and subordinate units of it such as a division, an operation brigade, a regiment, and a battalion are disposed on the SPIDER network grid of a corps.
  - Also, four types of traffics are exchanged in the simulated network model.

Analysis traffics

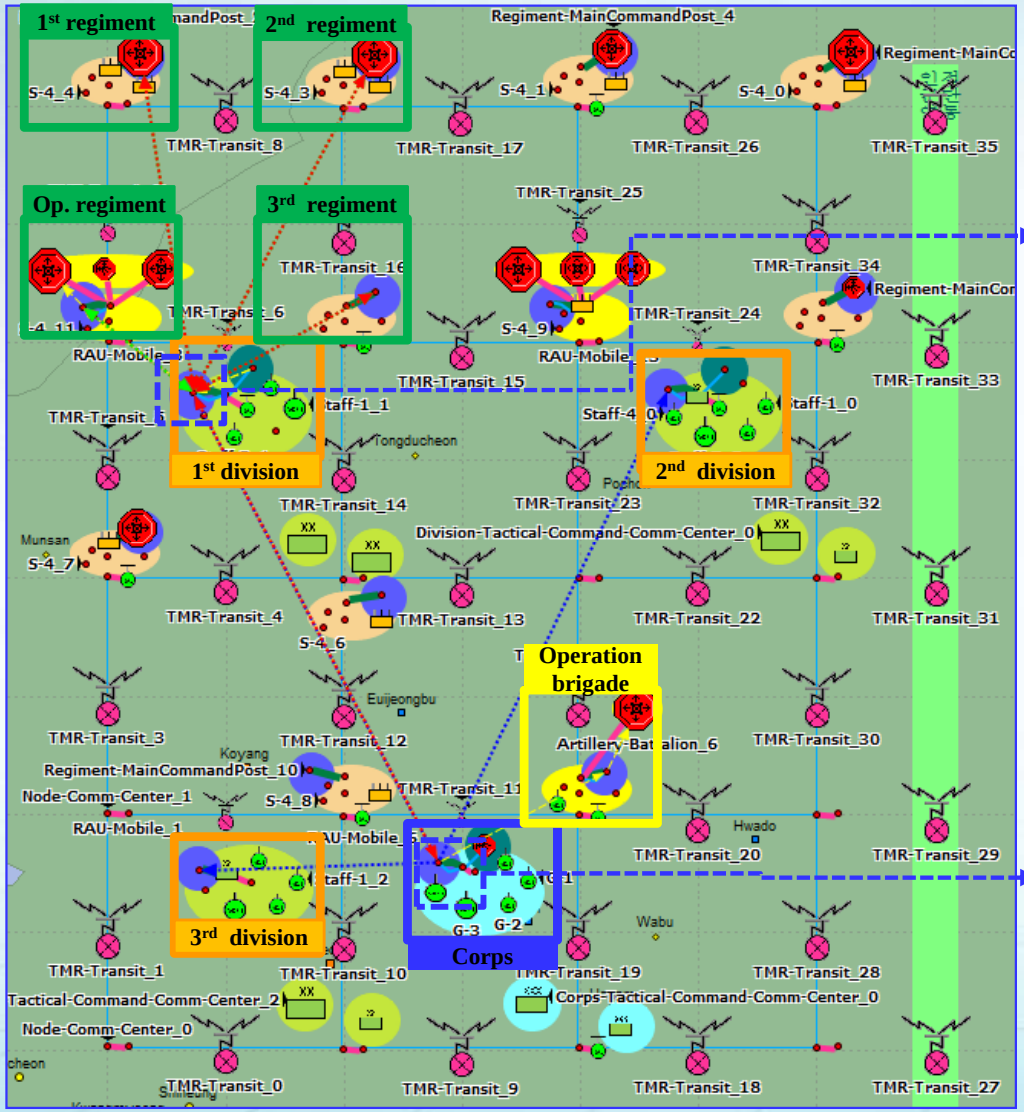
1. Simulated operation Traffic
   (aperiodic, small, real time)
2. Corps UAV Traffic
   (aperiodic, large, near real-time)
3. VTC Traffic
   (periodic, large, real time)
4. Background Traffic

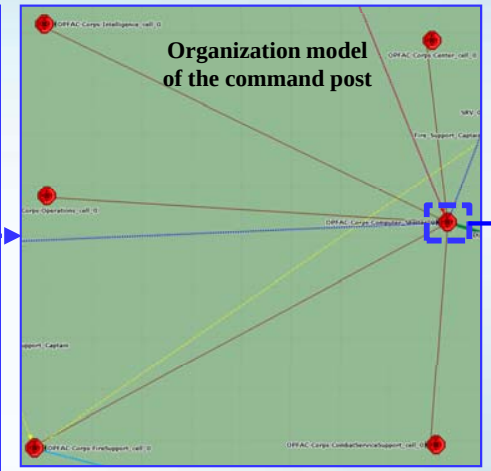
SPIDER grid in a corps and troop disposition

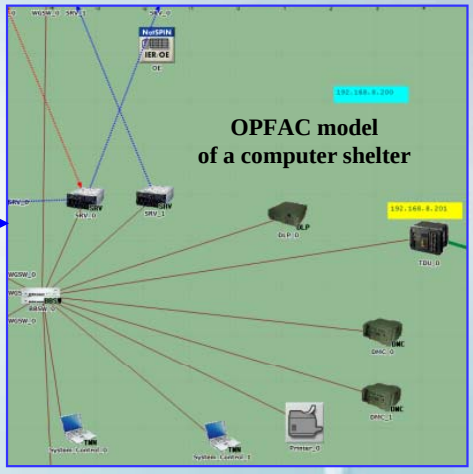


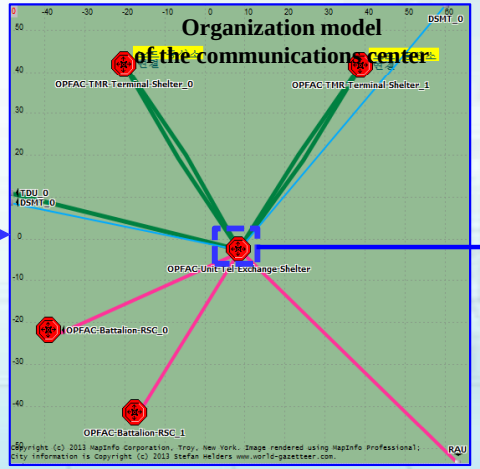
Scenario modeling and simulation

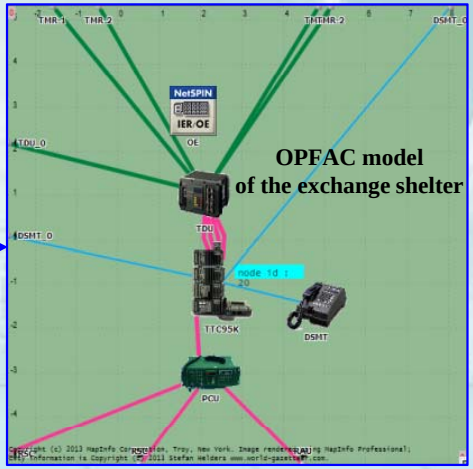
- Simulated scenario model for the analysis





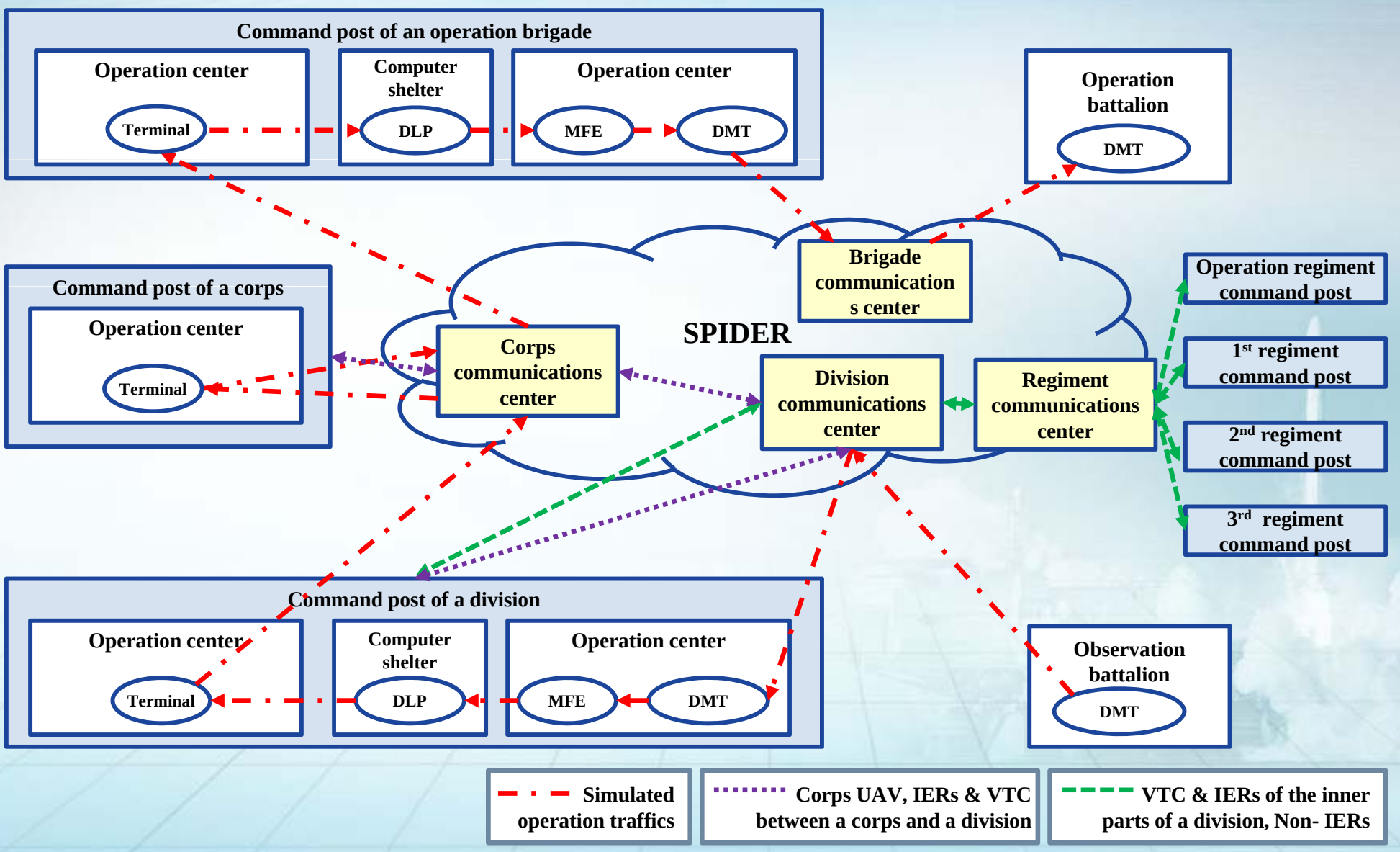






Scenario modeling and simulation

- Simulated traffic flows for the analysis



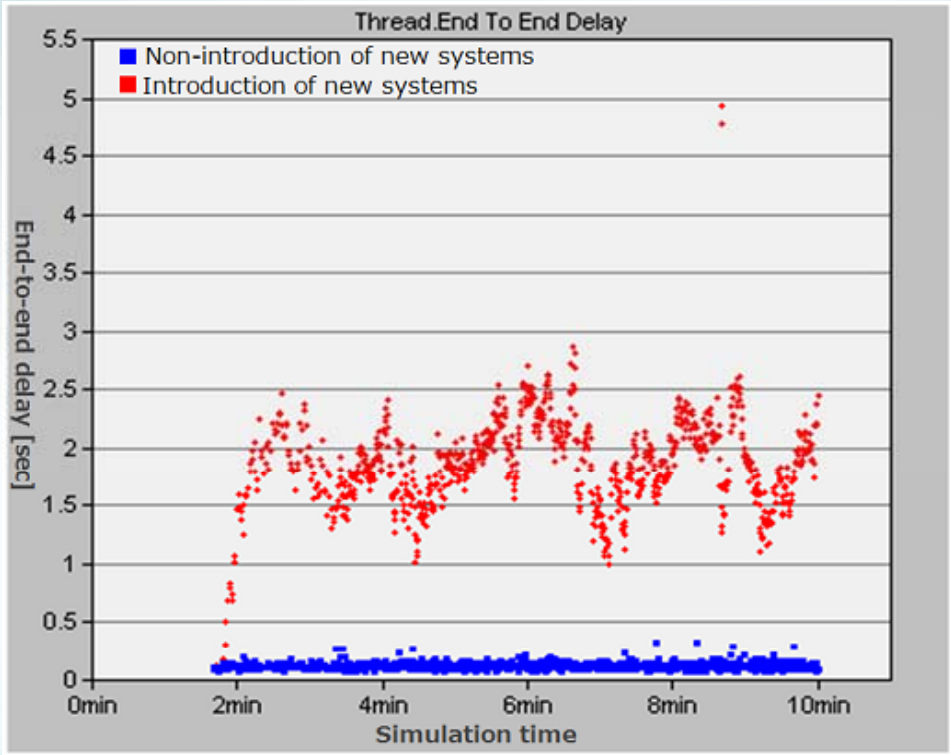
Scenario modeling and simulation

- Analysis traffic models

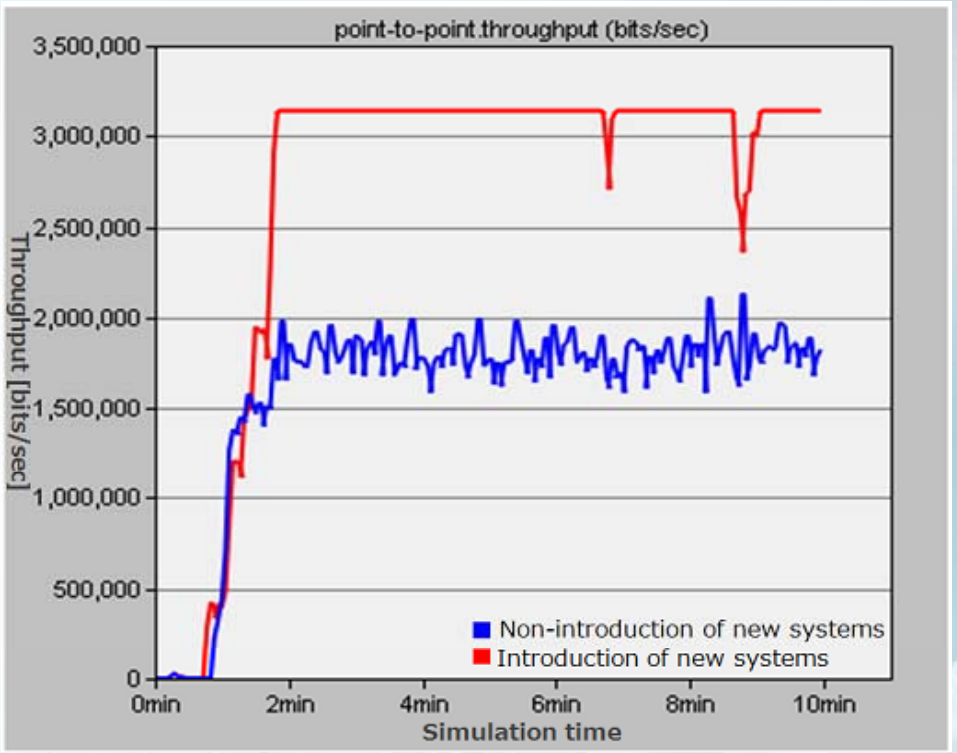
Types	Description		Size	Modeling method
Traffic for simulated operation	The system in the division transfers information to the system of the battalion under the corps.		600 bps	- IER & Thread modeling · generation period: constant (1) · generation size: constant
Traffic for UAV operation of the corps	main command post of the corps → main command post of the division		400 Kbps	- IP traffic flow modeling · generation period: exponential · generation size: exponential
Traffics for VTC	between the corps and the division	main command post of the corps → main command post of the division	300 Kbps	- Application modeling · standard application: VTC · frame generation characteristics: constant(0.2) · Tx frame: exponential(7500) · Rx frame: exponential(7500)
	the inner parts of the division	main command post of the division → command post of the regiment	300 Kbps	
Background traffics	IER between the corps and the division		80 Kbps	- Application demand modeling · generation period: constant · generation size: exponential (100)
	IER of the inner parts of the division		70 Kbps	
	Other Non-IERs		1200 Kbps	- Application demand modeling · generation period: constant · generation size: exponential (1500)

Scenario modeling and simulation

- Analysis and consideration of simulation results



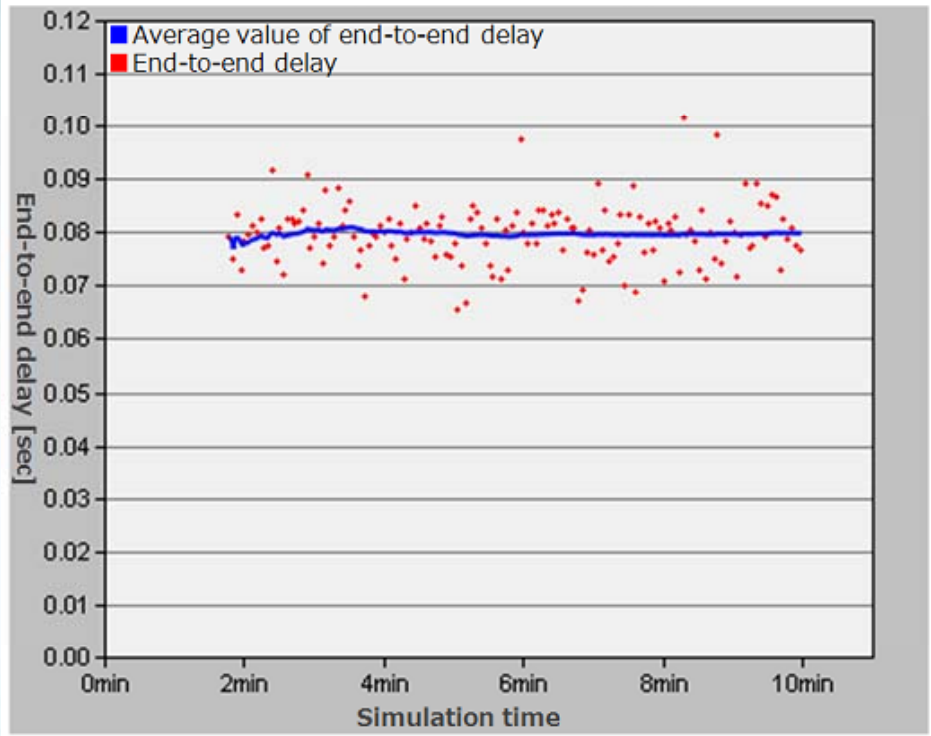
End-to-end delay of simulated operation messages



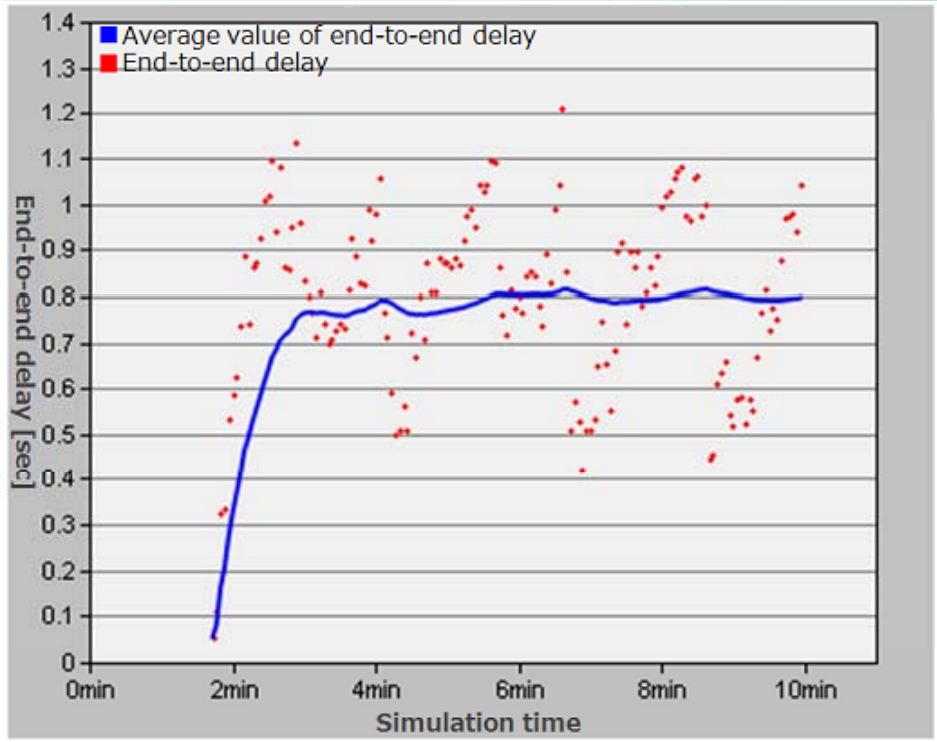
Throughput of the link between the command post and the communications center of a division

Scenario modeling and simulation

- Analysis and consideration of simulation results



End-to-end delay of VTC traffics in case of the non-introduction of new systems



End-to-end delay of VTC traffics in case of the introduction of new systems

Conclusions

Conclusions

- To analyze the information exchange capability between elements of the battlefield considering real communication environment
  - presented the modeling of military network of the NetSPIN
- In the situation that traffics of the SPIDER have been increased due to the introduction of new systems such as the UAV and the VTC system
  - the end-to-end delay of simulated operation messages and the throughput of links have been analyzed
  - the information exchange capability of existing communications network has been evaluated according to the introduction of the new system
- By analyzing effects of communications network due to the introduction of new systems beforehand utilizing the NetSPIN
  - causable problems were able to be forecasted in advance
- NetSPIN will be used effectively for analyzing the information exchange capability of the military and planning the communications network of it.


Thank you