Multi-Resolution Exercise Control Structure for NATO Education and Training Network

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ABSTRACT

The NATO Education and Training Network (NETN) project will deliver to NATO a distributed Education and Training Capability that will comprise also an integrated joint live, virtual and constructive simulation environment. The Initial Operating Capability of NETN is a multi resolution distributed modelling and simulation capability, in the form of NATO Training Federation (NTF) by Exercise Steadfast Joiner in November 2008. To be able to make use of the capabilities offered by NTF efficiently exercise control (EXCON) structure needs to be modified. Preliminary ideas about the new EXCON structure are presented.

1.0   INTRODUCTION

The NATO Education and Training Network (NETN) project will deliver to the Alliance and Partners a distributed Education and Training Capability that will comprise distance learning and shared scenarios database capability alongside a tool box that will ultimately contain, as technology matures, a mix of live, virtual and constructive simulation. The near term objective of the project is to provide the Alliance with an Initial Operating Capability of multi resolution distributed modelling and simulation, in the form of NATO Training Federation (NTF) by Exercise Steadfast Joiner in November 2008. NTF will be initially based on joint conflict and tactical simulation (JCATS) and joint theatre level simulation (JTLS) part of the US joint multi resolution modelling (JMRM) system. NTF will grow from JCATS-JTLS federation to a NATO live virtual constructive simulation environment with the addition of the CAX tools and C2 systems from the NATO and partner nations.

NETN will provide NATO with a multi resolution CAX environment where nations, tactical headquarters provided by nations, and all command levels in Allied Command for Operations (ACO) can join the same exercise. Joint Warfare Centre (JWC), Joint Force Training Centre (JFTC) and NATO School (NS) will be the first level customers of NETN. Allied Command for Operations (ACO) and nations are the second order customers. NC3A and NCSA will be the facilitators.

The NATO exercise structure and process need to be modified for multi resolution exercises because both tactical and operational level training audience with different training objectives will be present in such an exercise. This impacts on almost everything including scenarios, databases, map and geographical data requirements, exercise control (EXCON) organization and CIS environment. Among these we focus on EXCON structure, which needs to be modified for NETN. Temporal and spatial transitions between operational and tactical levels can be done based on the type of operations, unit or area of operations in a multi resolution exercise. EXCON structure should be able to tackle the challenges for these transitions

and the management of a multi resolution exercise. The synchronization of events and incidents in various resolutions without hampering the training objectives for each level is a difficult task and requires a multi resolution EXCON structure.

In this paper, we first introduce the current NATO exercise structure for CAXs, and the factors influencing the design of a distributed multi resolution exercise. Then we examine the new EXCON components required for a multi resolution exercise. The integration of these components and their interrelations are also explained in the same section. We conclude our paper in Section 4.

2.0 FACTORS INFLUENCING THE EXERCISE ARCHITECTURE DESIGN

2.1 Typical Steadfast Exercise Construct

A typical steadfast exercise construct is depicted in Figure 1. Two main parts of this construct is the training audience (TA) and exercise control (EXCON). Although the tasks of OCE and OSE, apart from TA and EXCON will be affected by multi resolution exercise construct, OCE and OSE related planning groups and models does not need to be modified except for the exercise evaluation (EXEVAL) organization. NTF and multi resolution exercises will impact on the organization of TA, and most notably on the EXCON model.

The typical *Steadfast Exercise TA* has two levels: a joint force command (JFC) and component commands (CC). Land, maritime and air CC (LCC, MCC, ACC respectively), as well as, special operations and psychological operations CC (SOCC and POCC respectively) normally join to the Steadfast exercises as primary TA (PTA). Sometimes one, multiple or all of CC and/or even JFC may be a secondary TA (STA) in a Steadfast exercise. It is also typical to have an NBC joint assessment team (JAT), a Chemical Biological Radiological Nuclear (CBRN) battalion and joint logistics support group (JLSG) as PTA. When a deployable joint task force (DJTF) is deployed in the exercise, ACC Forward and/or MCC Forward are also deployed together.

Typical EXCON model is shown in Figure 2. Training team (TT) consists of mentors, observer/trainers (O/T), subject mater experts (SME) and analysts. TT is deployed with TA, observe TA, provide on site instructions and training, and collects inputs for the after action review (AAR) and the evaluation of TA. Exercise centre (EXCEN) is the organization responsible for the consistent and coherent flow of the exercise according to the exercise objectives. EXCEN is explained in detail below. Experimentation team runs the experiments planned in conjunction with the exercise. Finally support team has the elements like real life support (RLS), visitor officer bureau (VOB), public information centre (PIC), security office and C4 event support team.

EXCEN functions can be categorized into five broad classes as situation centre (SITCEN), higher control (HICON), lower control (LOCON), white cell and situation forces (SITFOR). SITCEN monitors the current status of the exercise closely and steers it according to the training objectives. HICON and LOCON represent the command levels/echelons that would normally be at the level above and below the TA respectively. White cell is a response cell that is composed of subject matter experts (SME) or role players representing agencies, organizations, institutions and individuals outside of the NATO or opposing force structure. SITFOR is the cell that manages the status of all the NATO and opposing forces in the scenario except for the ones represented by TA, HICON and LOCON.
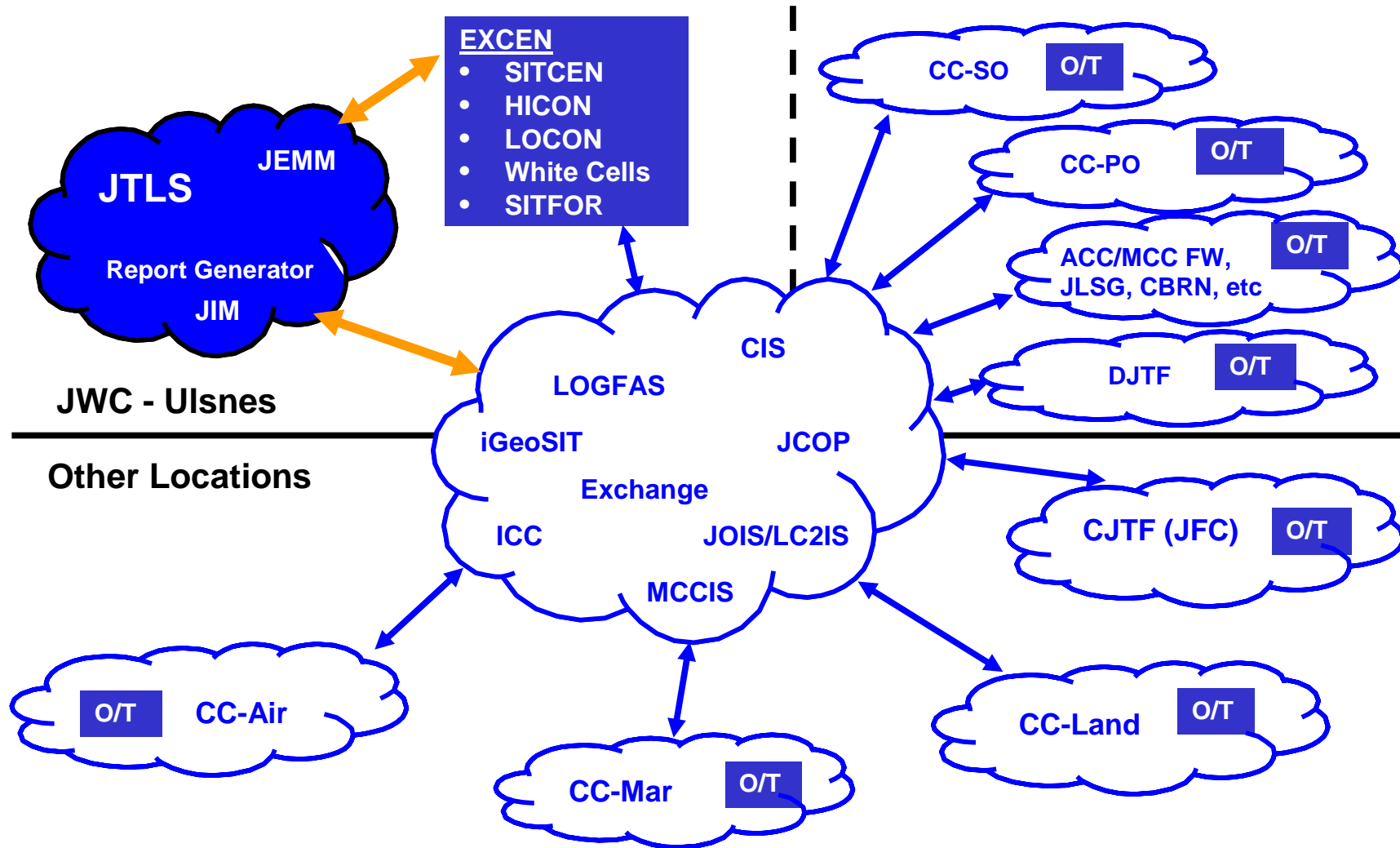
EXCEN
- **SITCEN**
- **HICON**
- **LOCON**
- **White Cells**
- **SITFOR**

JTLS

JEMM

Report Generator

JIM

JWC - Ulsnes

Other Locations

CIS

LOGFAS

iGeoSIT

JCOP

Exchange

ICC

JOIS/LC2IS

MCCIS

CC-SO O/T

CC-PO O/T

**ACC/MCC FW,
JLSG, CBRN, etc** O/T

DJTF O/T

CJTF (JFC) O/T

CC-Air O/T

CC-Mar O/T

CC-Land O/T

Figure 1 Typical Steadfast exercise construct.
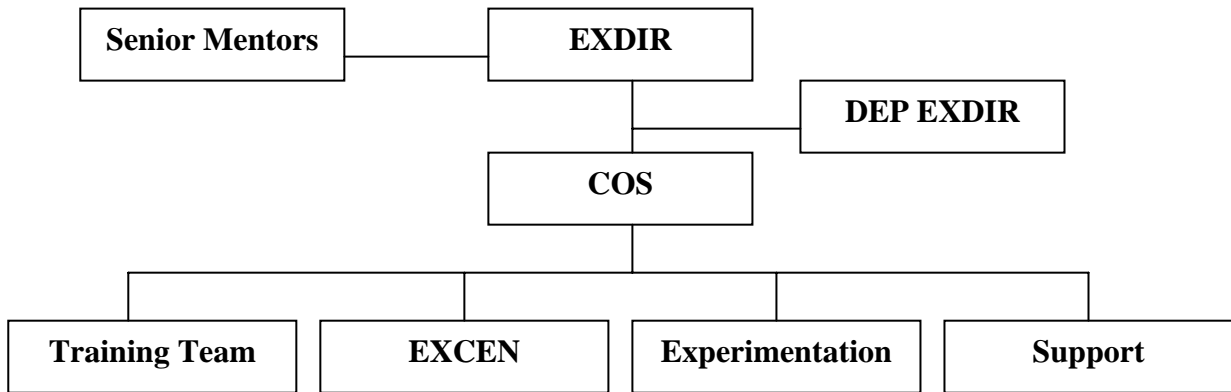
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┌──────────────────┐        ┌──────────────────┐
│  Senior Mentors  │────────│      EXDIR       │
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┌──────────────────┐ ┌──────────┐ ┌────────────────────┐ ┌──────────────┐
│  Training Team   │ │  EXCEN   │ │  Experimentation   │ │   Support    │
└──────────────────┘ └──────────┘ └────────────────────┘ └──────────────┘
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Figure 2 EXCON Model.

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                    ┌──────────────────┐
                    │   Chief EXCEN    │
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     ┌──────────┬──────────┬─────┴────┬────────────┬──────────┐
┌──────────┐ ┌──────────┐ ┌──────────┐ ┌────────────┐ ┌──────────┐
│  SITCEN  │ │  HICON   │ │  LOCON   │ │ White Cell │ │  SITFOR  │
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                                            │
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                          │ Role players │ │  Media cell  │
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Figure 3 EXCEN Model.

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                    ┌──────────────────┐
                    │  Chief SITCEN    │
                    └──────────────────┘
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│   SCENARIO   │ │   MEL/MIL    │ │  EVENT MNG   │ │   CAX Spt    │
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│   Scenario   │ │   RFI    │   │  Functional  │
└──────────────┘ └──────────┘   │    Desks     │
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Figure 4 SITCEN Model.

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                        ┌─────────────────┐
                        │   Chief LOCON   │
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┌──────┐  ┌──────┐  ┌──────┐  ┌──────┐  ┌──────┐
│LCC RC│  │ACC RC│  │MCC RC│  │SOCC RC│ │POCC RC│
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              ┌──────────┬──────────┬──────────┐
           ┌──────┐  ┌──────┐  ┌──────┐
           │CBRN RC│ │JLSG RC│ │Other RC│
           └──────┘  └──────┘  └──────┘
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Figure 5 LOCON Model.

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              ┌─────────────┐
              │  Chief RC   │
              └──────┬──────┘
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┌────────────┐ ┌────────┐ ┌────────────┐ ┌────────────┐
│MEL/MIL Coor│ │Planners│ │Battle Captain│ │M&S Operators│
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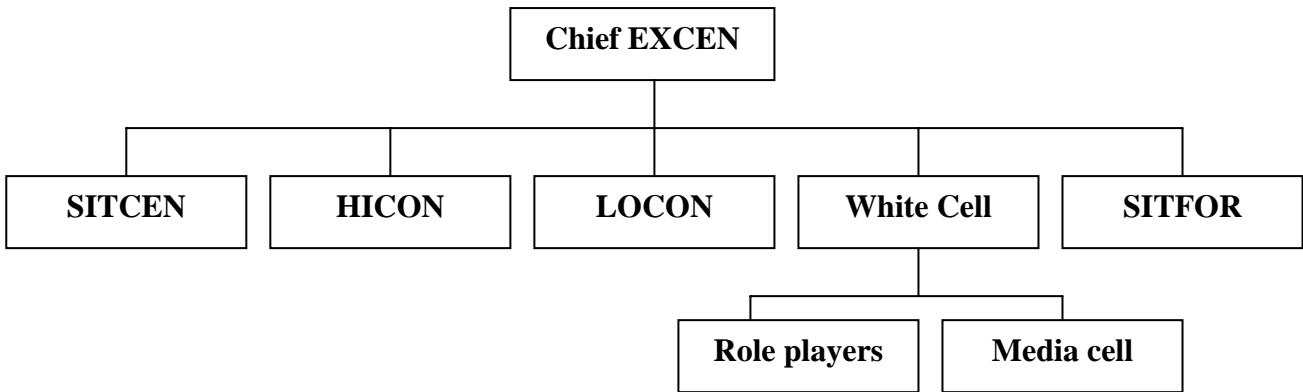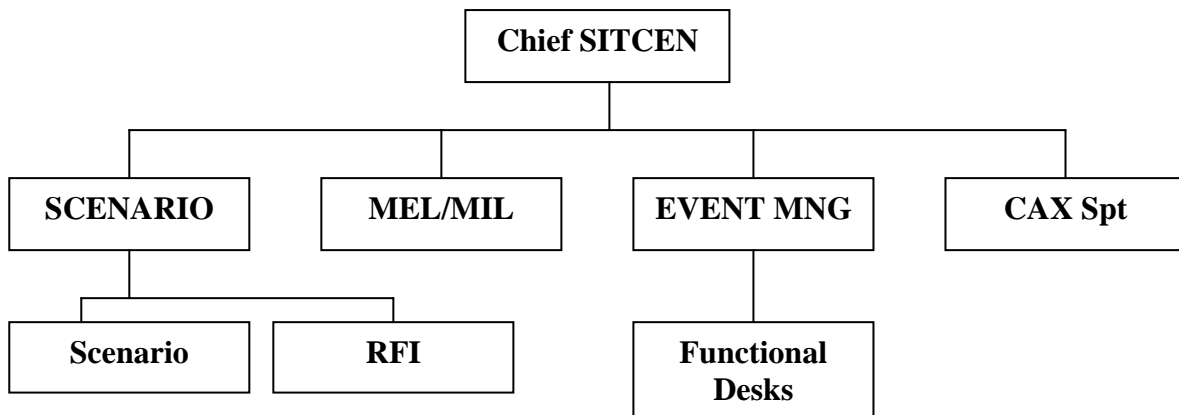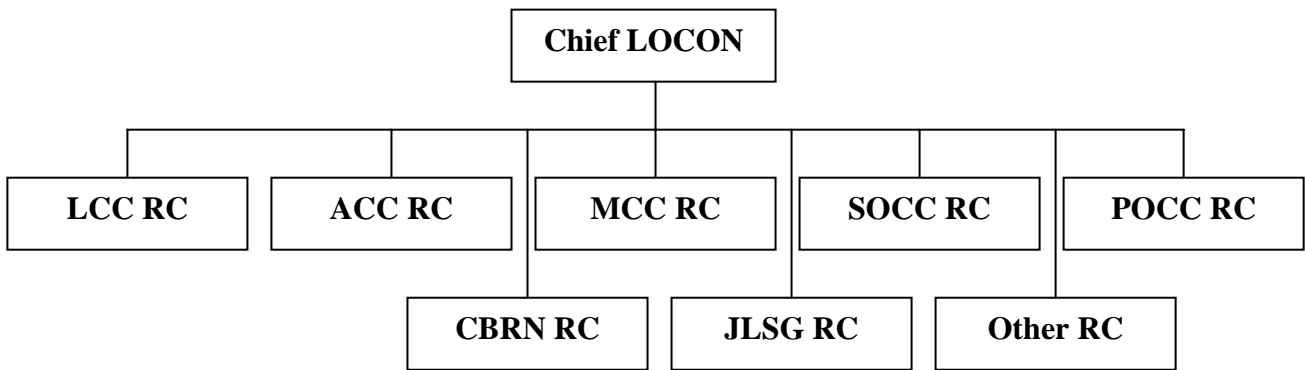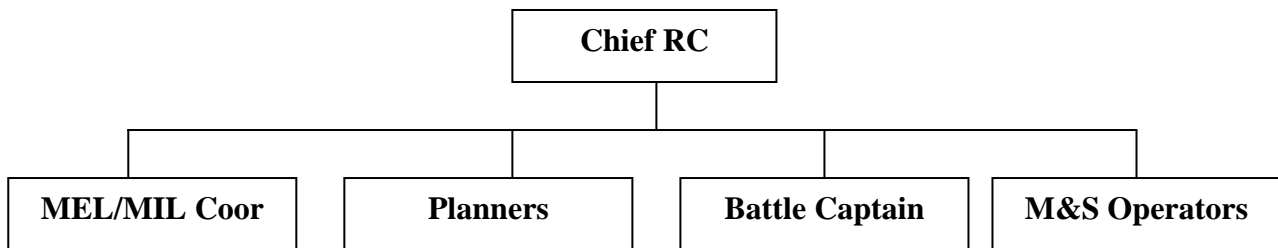
Figure 6 RC Model.

The first important team in SITCEN is the scenario team, which is responsible to maintain and manage the scenario related information, and to respond the request for information (RFI). They have a close connection and coordination with the SITFOR cell. MEL/MIL team is another important team within SITCEN. MEL/MIL manager closely monitors the status of every injection, and manages dynamic scripting and injection of incidents. MEL/MIL team ensures that every injection serves for a training objective (TO), and the coverage of TA, TO and the exercise duration by the injections are very well balanced. Event managers manage the main events from start to end. They ensure that TO for the event are achieved by the TA. They closely follow the feed back from O/Ts and response cells (RC), design new incidents consistent with the scenario, simulation, the overall event and TO, and ensure that the planned incidents are injected at the correct time, i.e., consistent with the scenario and status, to the targeted TA. They coordinate with the SMEs in functional desks, CAX coordinator and MEL/MIL manager. CAX Support team in SITCEN provides the interface between the CAX Delivery Team and SITCEN.

LOCON and HICON consist of RC. The number of RC is dependent on the scenario and the TA. Each RC is made up of a MEL/MIL coordinator, a number of planners, a battle captain, and a number of simulation operators. Planners in an RC act as the subordinate or superior of the TA. When an order or report received from the TA, planners make their plans according to the current situation and the doctrine. Then they hand over the plan to the battle captain. The battle captain is the interface between the planers and the simulation operators. He/she is an experienced operational planner that also has an insight about the capabilities of the simulation. He/she converts the plans to a sequence of orders for the simulation. Than the operators enter the orders into the simulation. The results and reports from the simulation are also passed to the planners, who transform them into realistic reports for the TA. Standard reporting procedures and formats should be applied in passing the results to the TA.

In a typical Steadfast exercise, the TA is deployed in multiple sites. EXCON and some part of TA stay in JWC or JFTC. A part of EXCON may sometimes be deployed to a remote site together with a part of the

TA. For example in Steadfast Jaw 06, LCC response cell was in Istanbul with LCC while the rest of EXCON was in Stavanger. A small team that represents SITCEN was also located with LCC RC in Istanbul. Detached part of SITCEN and LCC RC were called the extended EXCON.

We can summarize the results of this section as:

- *NATO is already conducting multi level exercises*, at least two levels, i.e., JFC and CC.
- *NATO has already conducted distributed exercises*.

The difference of NTF and Snow Leopard from the current synthetic environment will be the capability to conduct multi resolution exercises. Multi resolution exercises will impact on mainly SITCEN, LOCON and HICON models.

2.2   Switching Between the Resolutions

Initial NTF will have two combat models, namely joint theatre level simulation (JTLS) and joint conflict and tactical simulation (JCATS). JTLS is a joint highly aggregated constructive simulation system, which fits operational or higher theatre level simulation requirements. In JTLS terrain is modelled by hexagons. Typical hexagon size is between 6.5 and 7.5 km from one end to the other, i.e., one side is between 3 and 3.5 km. That best fits when the simulated units (simulation entities) are battalions, wings/air packages, i.e., multiple air crafts in an air mission, and ships (frigates, submarines, etc.) JCATS is a joint high resolution constructive simulation, where the details like a single troop can be simulated by using high resolution terrain and environmental data. It is also possible to aggregate the simulated entities into units and command them as aggregated units in JCATS. When the training audience is lower than or equal to component command (corps) level, JCATS provides better fidelity simulation. NTF will connect these two constructive simulations through high level architecture (HLA), i.e., run time infrastructure (RTI). In NTF the entities simulated in JCATS is able to interact with the units in JTLS. For example an aircraft in JCATS can fire a missile to a unit in JTLS. When this capability is available, highly aggregated JTLS can be used as long as higher resolution simulation is not needed. When simulation resolution higher than the one that JTLS can provide or the simulation of high resolution tactics is required, JCATS can be used. The outputs of these two simulations update the attributes of the units and entities in both of the simulations.
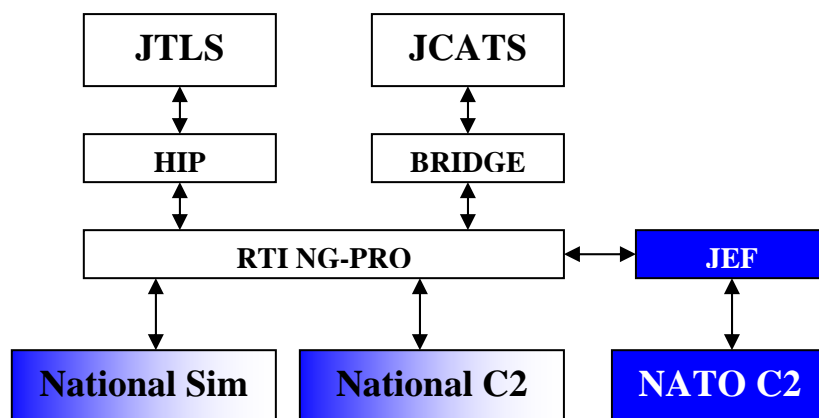

Figure 7 NATO Training Federation.

Joint exchange federate (JEF) is being developed by NC3A to provide the mediation between NTF and NATO C2 systems, mainly ICC, MCCIS and LC2IS. JEF will also be a federate that connects to NTF through HLA. NATO modelling and simulation group (NMSG) task group MSG-068 is developing the

technical specifications and standards for the nations to join NTF with their national C2 or simulation systems.

When NTF is available, some entities will be simulated by JCATS, and some units in the same theatre are simulated by JTLS. The entities in JCATS will be able to interact with the units in JTLS, which means an aircraft in JCATS can fire a missile to a ship in JTLS. This creates a new question to answer: "Which entities or units should be simulated in JTLS or JCATS?" This responsibility of simulation can also be switched between JTLS and JCATS from time to time. The mapping between the simulation requirements and simulation systems can be based on the following criteria:

 - *Geography based sharing of the units and entities:* The entities can be shared between multiple simulation systems based on geography. As shown in Figure 8 we can give the simulation responsibility of a certain area to JCATS, while the responsibility for all the other regions stays with JTLS. The JCATS may also have multiple geographic regions and change the areas from time to time. For example, Region A can be in JCATS at the beginning for a while, and then it may be returned to JTLS and Regions B and C can be taken to JCATS. Note that in any case there can be only one JTLS and one JCATS server in the initial version of NTF. This implies that when we have multiple geographical regions for JCATS, they need to be simulated at a single JCATS server.
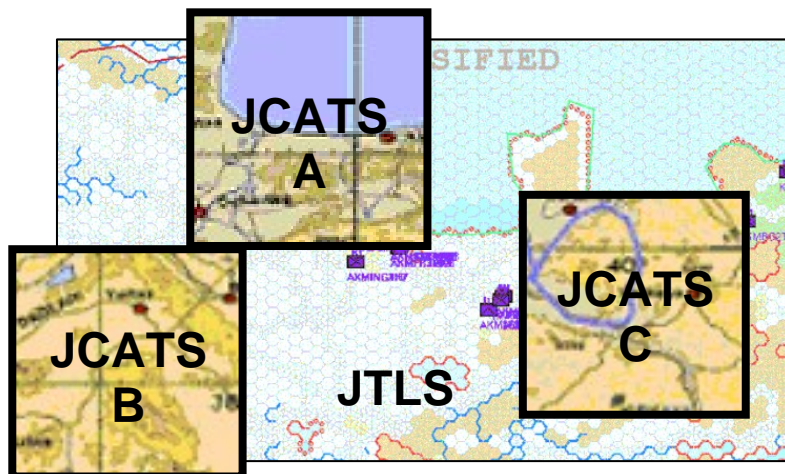
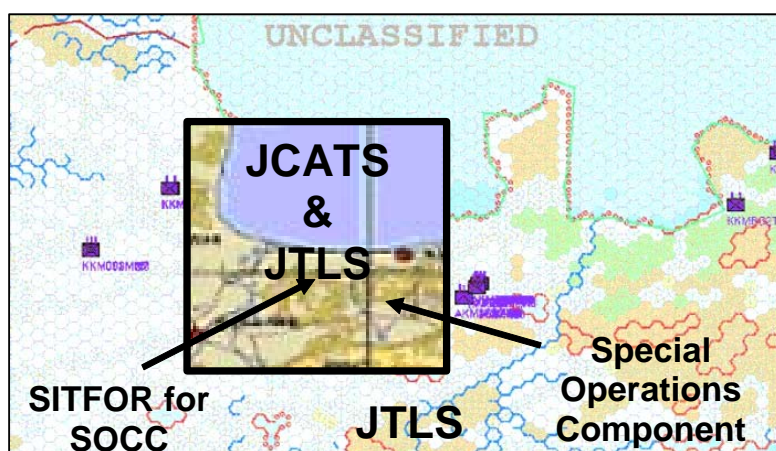**Figure 8 Geography based multi resolution construct.**

Figure 9 Component based multi resolution construct.

- *Component based sharing of the units and entities:* To simulate everything related to a specific component in one of the simulations while simulating the others in another simulation is also an option. For example we can simulate everything related to special operations component at JCATS, and all the other components at JTLS. In this case, in the same area there may be entities simulated in JCATS and units simulated in JTLS. This increases the probability that an entity in JCATS interact with a unit in JTLS.

- *Nation based sharing of the units and entities:* With NTF it will be possible to have a national headquarter among the TA. When this is the case, all the entities for the nation can be simulated in a simulation system while the NATO Headquarters are simulated in another simulation. This looks similar to the component based sharing.
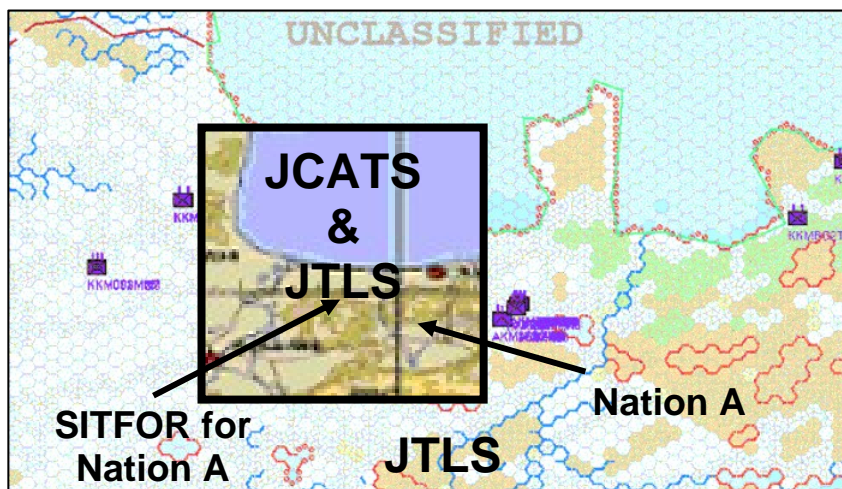
Figure 10 Nation based multi resolution construct.

Figure 11 Service based multi resolution construct.

- *Service based sharing of the units and entities:* All the entities for a service can be simulated in a simulation system while all the others are in another simulation system. For example, we can use one of the simulations to simulate maritime operations, and the other for all the other ground and air operations.

- *Type of operations based sharing of the units and entities:* Finally operations like counter improvised explosive devices (counter IED), long distance reconnaissance, river crossing, amphibious, riot control can be simulated in JCATS and the others in JTLS.

Figure 12 Type of operations based multi resolution construct.

2.3   Highly Aggregated and High Resolution Events

In multi resolution exercises, there will be multiple sets of training objectives. Moreover, each of these sets of training objectives will require events and incidents designed in resolutions different from each other. For example, an injection in highly aggregated level can be as follows:

"Multiple reports received confirming protest in the vicinity of MANAKARA has commenced. The demonstration is reported by the local news media and confirmed by guards on patrol. Estimates in excess of 10,000 people. So far, the protest is peaceful."

Such an injection may not be enough for a tactical headquarter, and need to be detailed with addresses, distribution of the people to various streets, the details about the movement patterns of the crowd, the locations of patrols provided by the other units, more detailed intelligence about the possible attempts by the crowd, etc.

Although there are different sets of objectives and multiple resolutions for events and incidents, all of them should be coherent and consistent with a single white truth. Similar to simulations a highly aggregated event may encapsulate several high resolution events. Or an incident in highly aggregated level can be perceived as an event at the high resolution level. This requires a very careful coordination of

events and incidents between different resolution levels. Moreover, the planning made for a highly aggregated incident may create many incidents not planned and not expected for the high resolution TA.

All these also make an impact on the scenario, which needs to be enough for all sets of training objectives, as well as, resolution levels.

2.4   Models for Multi-resolution Construct

It is possible that multi resolution exercise construct is applied to the typical steadfast series exercise TA. In this approach one or multiple CC level TA can be in high resolution synthetic environment while the other CC and JFC are in highly aggregated. In this case a different set of training objectives can be developed for the high resolution TA, i.e., the TA represented in JCATS, and highly aggregated TA, i.e., the TA represented in JTLS. For example, the LCC and SOCC can be simulated in JCATS, and the others can be in JTLS.
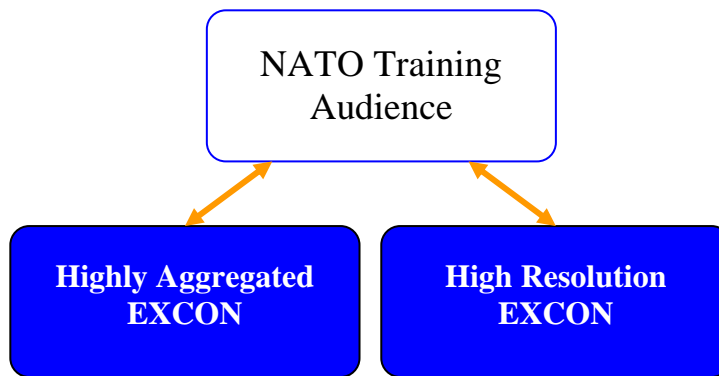
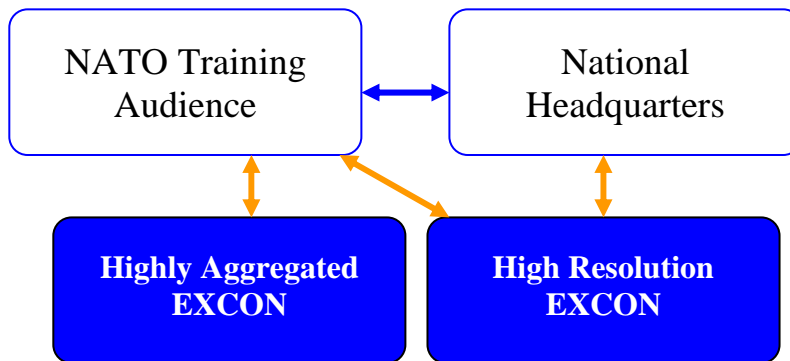**Figure 13 Typical Steadfast TA in multi resolution construct.**

Figure 14 Extended Steadfast TA in multi resolution construct.

TA configuration can also be extended when multi resolution exercise capability is available, and national headquarters can also join into NATO exercises as PTA. The echelons that the TA represents and their hierarchy impact on the EXCON and EXCEN models. There are two possible configurations for the new TA:

- All the echelons in the TA are either the superior or the subordinate of an echelon represented by the TA, and there is no gap in the command hierarchy within the TA.
- There can be gaps between the echelons in the TA. For example an echelon lower comparing to the other echelons in the TA may not have a direct superior head quarters within the TA. The most important impact of this approach is on the RC structure. In this case there may be response cells that act as a LOCON for a part of the TA while the same RC is acting as HICON to another part of the TA.
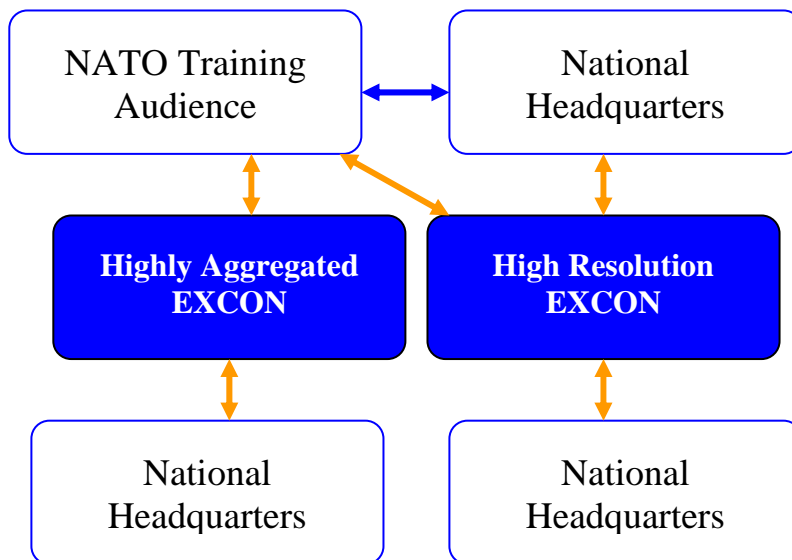
Figure 15 Extended Steadfast TA with command hierarchy gaps in multi resolution construct.

3.0 EXCON AND EXCON CENTRE ORGANIZATION FOR MULTI RESOLUTION EXERCISES

EXCON Centre (EXCEN) will be deployed to multiple sites in multi resolution exercises. There will be three types of EXCEN related organizations: main EXCEN, extended EXCEN and forward EXCEN. Main EXCEN will be typically deployed in JWC, and extended EXCEN will be deployed in JFTC. The number of forward EXCEN depends on the number of nations, and they will be deployed with the national sites. Apart from EXCEN, the modification of training team may be needed for the new TA with multiple set of training objectives. JWC and JFTC training teams will work together for this. When nations are also in the exercise, they may also be supported by the O/Ts and mentors from JWC and JFTC depending on the training objectives of the nations and availabilities in the training team.

3.1 Main EXCEN

Figure 16 depicts the main EXCEN model for multi resolution distributed NATO exercises. In this figure, the boxes filled grey are the posts or cells created for multi resolution construct. They were not present in the typical Steadfast exercise constructs. The boxes filled yellow were also in the typical construct but they are modified for multi resolution construct. The blue boxes indicate a post or cell either in the extended EXCEN or detached response cell. They are depicted in a figure to show which posts from main EXCEN, extended EXCEN and detached RC are linked to each other.

CAX Support Cell is under the SITCEN in typical EXCEN model and consists of 3-5 posts, i.e., a CAX coordinator, a current MEL/MIL synchronizer, a future MEL/MIL synchronizer, a JTLS system manager and a CAX Manager. In the new construct, future MEL/MIL synchronizer and CAX manager posts are merged into the CAX manager post, and all the posts related to JTLS is also duplicated for JCATS. CAX Coordinator is responsible for the coordination of the CAX/system managers and synchronizers. CAX coordinator has also a link to the CAX coordinator in the extended response cell. Apart from this, each forward EXCEN will have a CAX liaison that has a direct link with the CAX coordinator in the main EXCEN. The CAX Coordinator in the main EXCEN is the one responsible for the overall consistency of the CAX support. CAX Support cell maintains close coordination with the SITCEN, HICON, RC, WC and SITFOR.
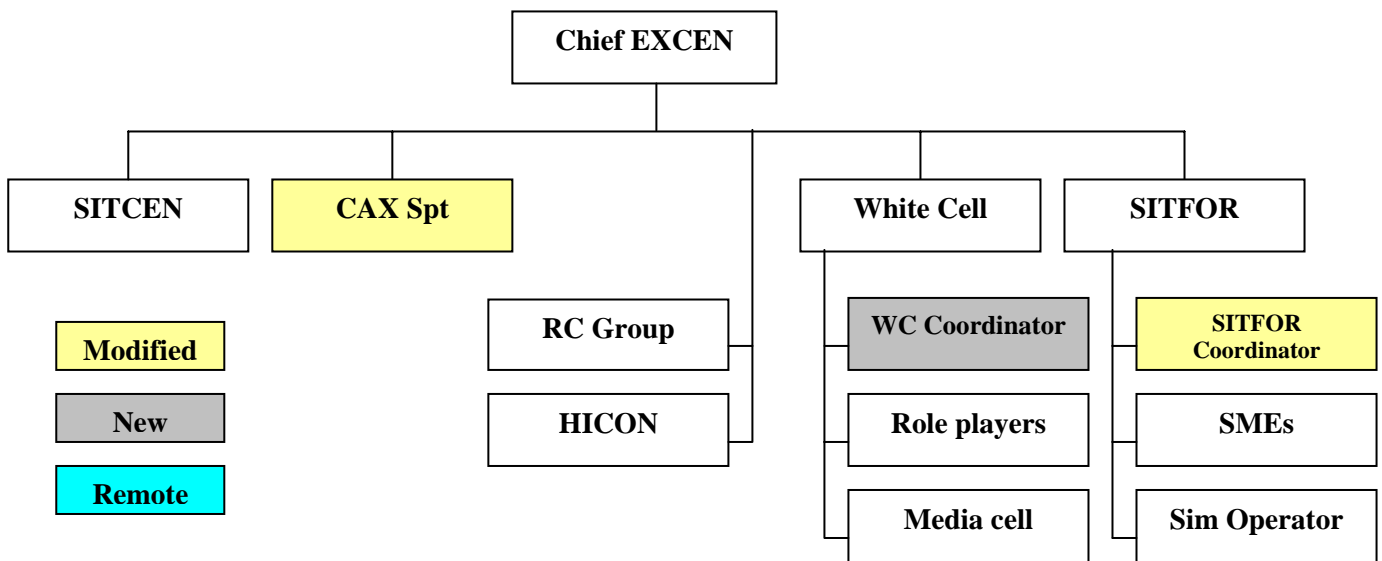
Figure 16 Main EXCEN Model.

SITFOR has a coordinator post in typical Steadfast construct. This post is also available in the new construct with increased importance and responsibilities. This person maintains also a close coordination with the SITFOR cell in the extended EXCEN.
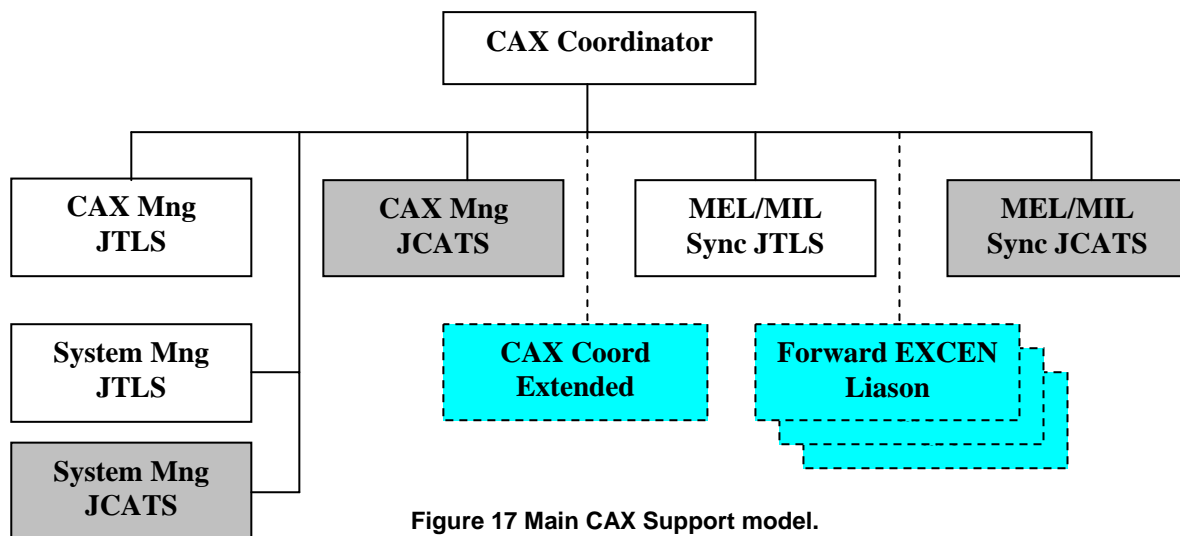
Figure 17 Main CAX Support model.

The main change in the SITCEN of main EXCEN is the addition of three coordination posts. One of these new coordinators is in the scenario team who stays in contact with the scenario chief in the extended EXCEN. The other two coordinating posts are in MEL/MIL cell, one of these is the inter resolution MEL/MIL coordinator who is responsible to coordinate the MEL/MIL with the inter resolution MEL/MIL coordinator in the extended EXCEN. As we explained before, an event may encapsulate other high resolution events. If this is the case, the event manager of that event is supported by a coordinator, who is responsible coordinating the flow of the encapsulating event with the related event managers in the extended EXCEN.
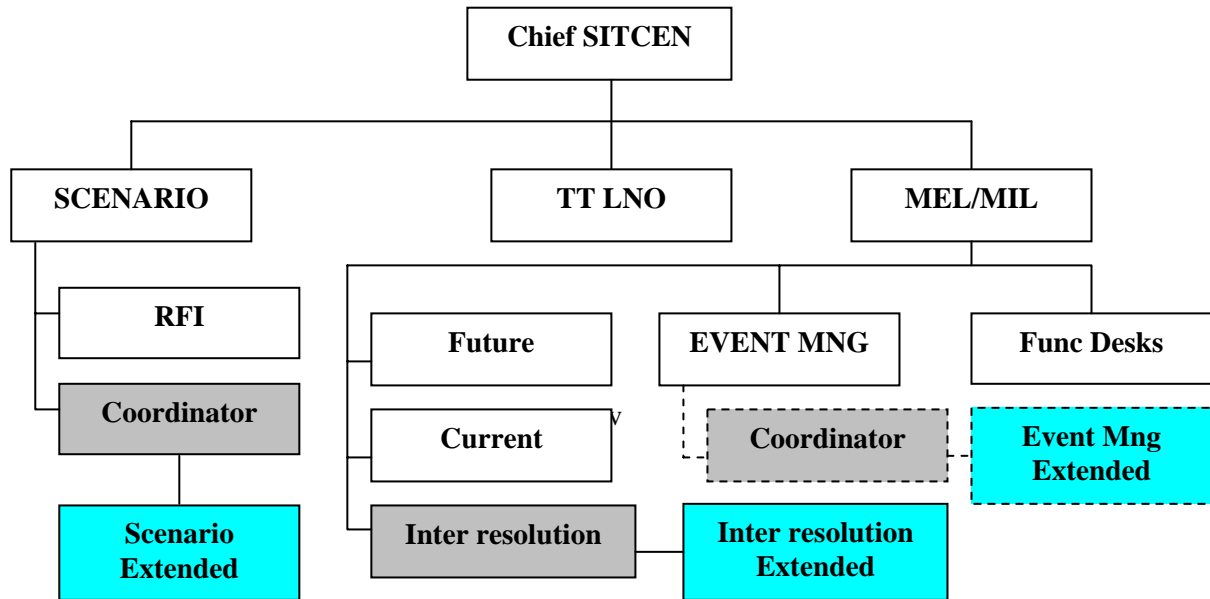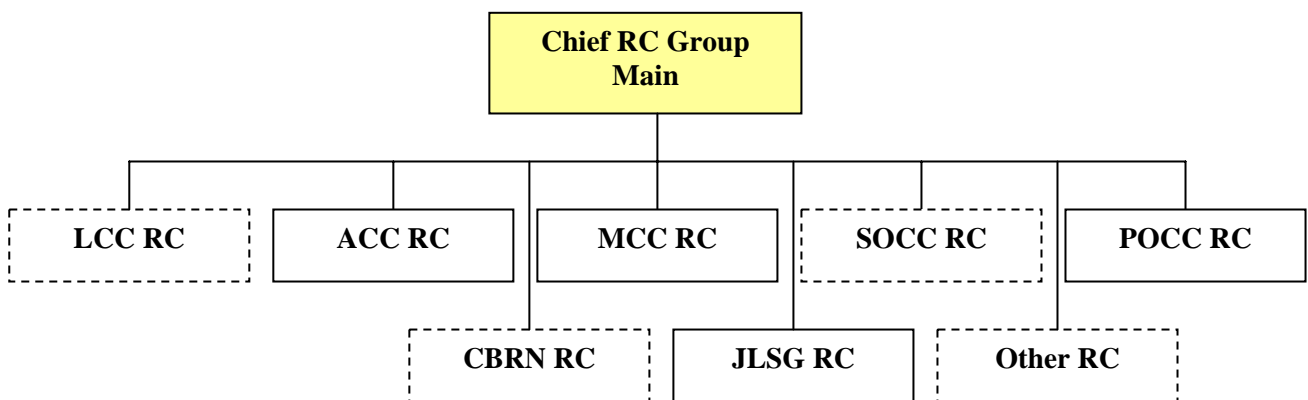
Figure 18 Main SITCEN Model.

Figure 19 MAIN RC Group Model.

In the new construct the name of LOCON is changed as RC group because some of the RC may act as LOCON for a higher headquarter while acting as a HICON for a national headquarter (e.g., a battalion headquarter that joints to an MRT) that does not have a direct superior in the TA. In the new construct some of the RC, such as, LCC, SOCC, CBRN, etc, may be located in the extended EXCEN. Another change in the RC group can be in the RC model. If an RC acts both HICON and LOCON, and the distance between these two is more than a single echelon, then planners for both HICON and LOCON roles may be required. For example, if the LCC response cell acts also as a HICON for a company, than it also needs to have at least one planner for the battalion. However, if the gap between the lower and higher level echelons is only one still one planner team can suffice. For example the planners in a brigade RC can act both as a LOCON for LCC and HICON for a battalion HQ.
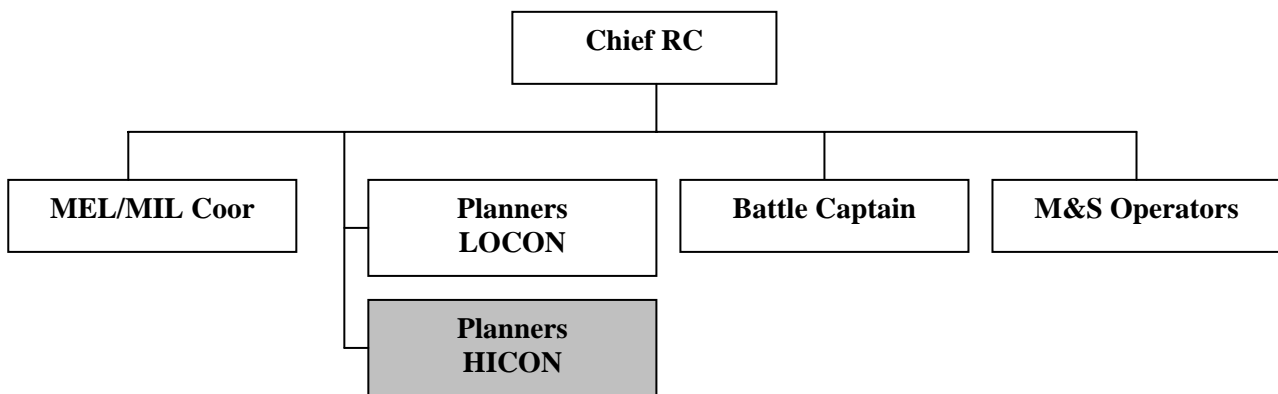
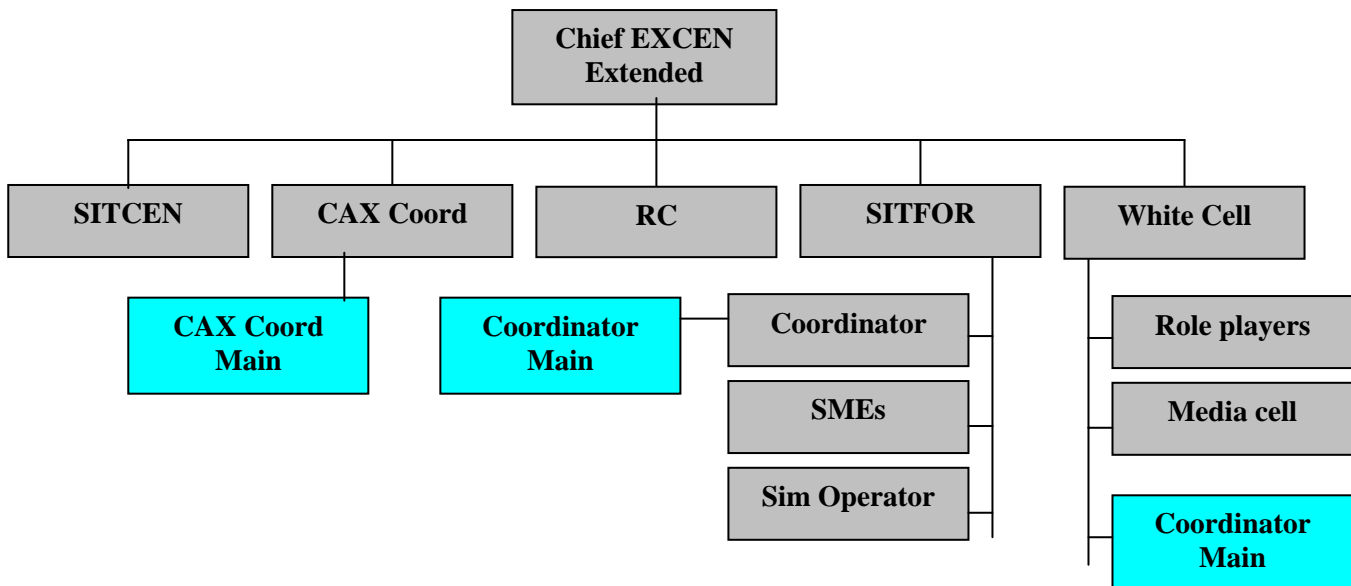**Figure 20 RC Model.**

3.2 Extended EXCEN

Figure 21 Extended EXCEN Model.

Extended EXCEN is almost a reduced replication of the main EXCEN. It is formed and run by JFTC in multi resolution exercises. The first difference from the main EXCEN is in the CAX Support Cell. The

extended EXCEN does not have a cell but a coordinator in contact with the main EXCEN CAX Coordination Cell. The main reason for this, it is highly recommended both JTLS and JCATS servers are co located for the time being. When that is technically and operationally more feasible to locate JTLS and JCATS servers separately, than extended EXCEN should have a CAX support cell with JCATS simulation/CAX managers and MEL/MIL synchronizer. The other difference is in the event managers. In the extended EXCEN if an event is a part of a highly aggregated event managed by the main EXCEN, event manager maintains contact and coordination with the coordinator of the encapsulating event in the main EXCEN.
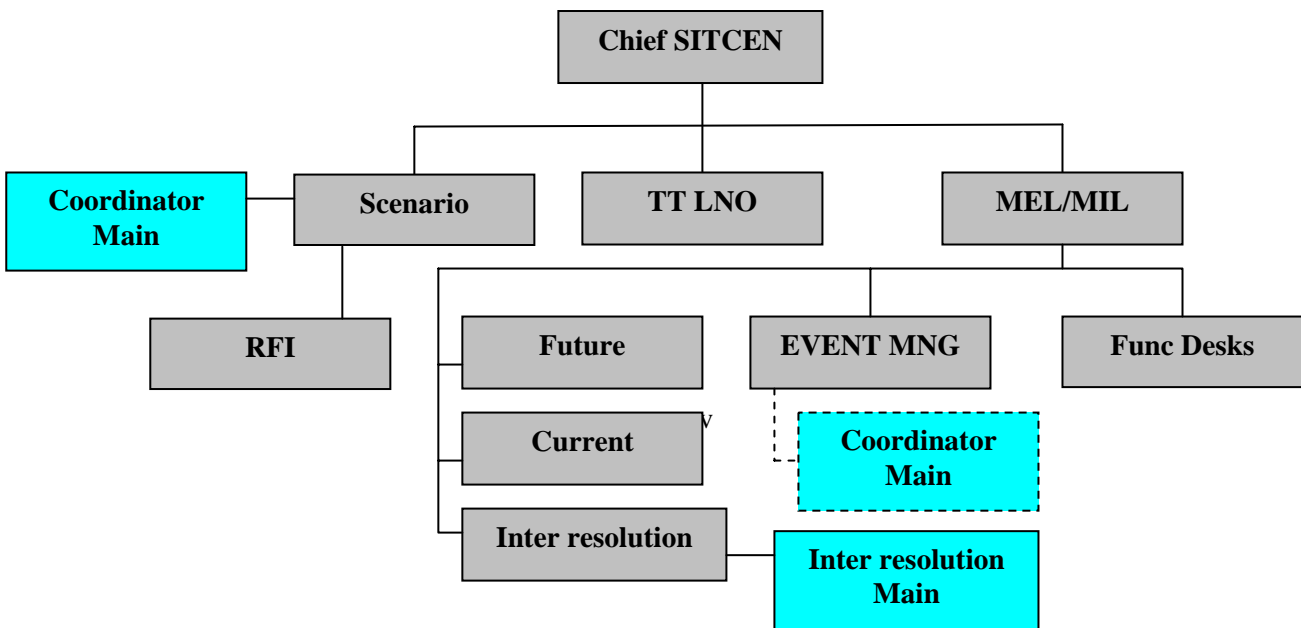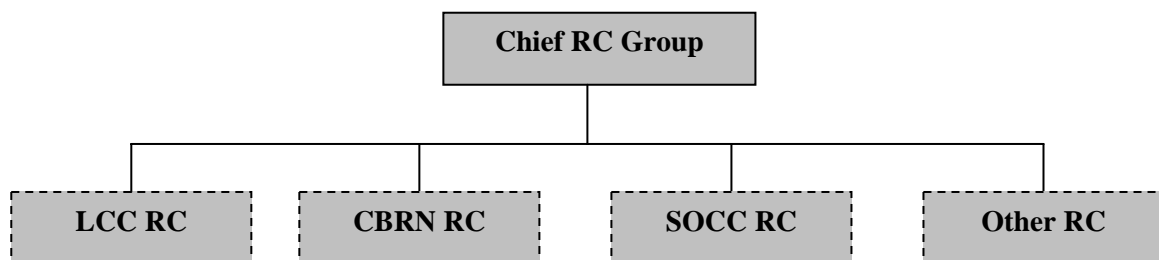

Figure 22 Extended SITCEN Model.

Figure 23 Extended RC Group Model.

```
                           ┌──────────────────┐
                           │     Chief RC     │
                           └──────────────────┘
        ┌────────────────┬──────────┴──────────┬────────────────┐
┌──────────────┐  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐
│ MEL/MIL Coor │  │   Planners   │  │Battle Captain│  │ M&S Operators│
└──────────────┘  │    LOCON     │  └──────────────┘  └──────────────┘
                  └──────────────┘
                  ┌──────────────┐
                  │   Planners   │
                  │    HICON     │
                  └──────────────┘
```
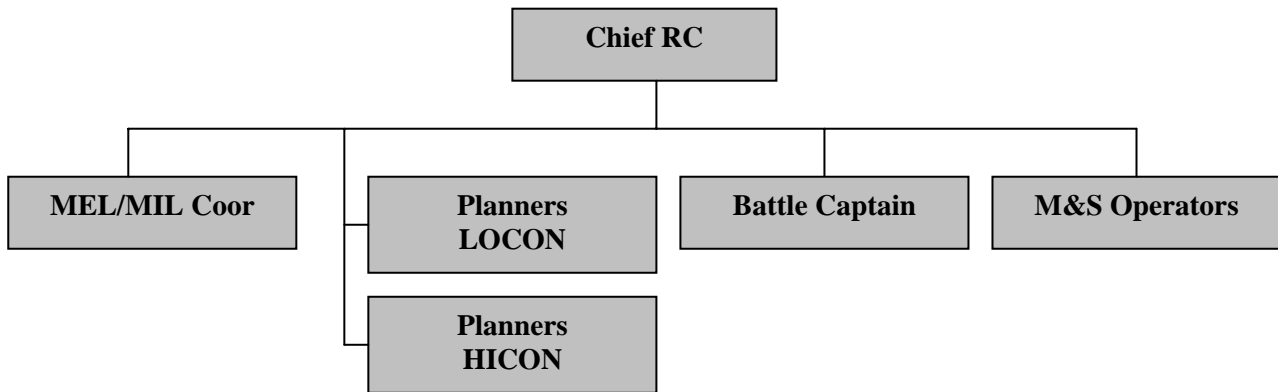
Figure 24 Extended RC Model.

RC group and RC models are the same as the main EXCEN. The only difference is about the probability that an RC in the extended EXCEN has both LOCON and HICON planners. It is much lower comparing to the main EXCEN.

3.2   Forward EXCEN

When a nation joins the exercise as a part of the PTA, RC for that audience is also provided by the nation. This RC together with its training audience can be located in JWC, JFTC or at a national site. In any case it is a typical response cell with a forward EXCEN liaison in contact with the CAX coordinator in main EXCEN. In some cases, the liaison in the forward EXCEN may have the contact with the CAX coordinator in the extended EXCEN.
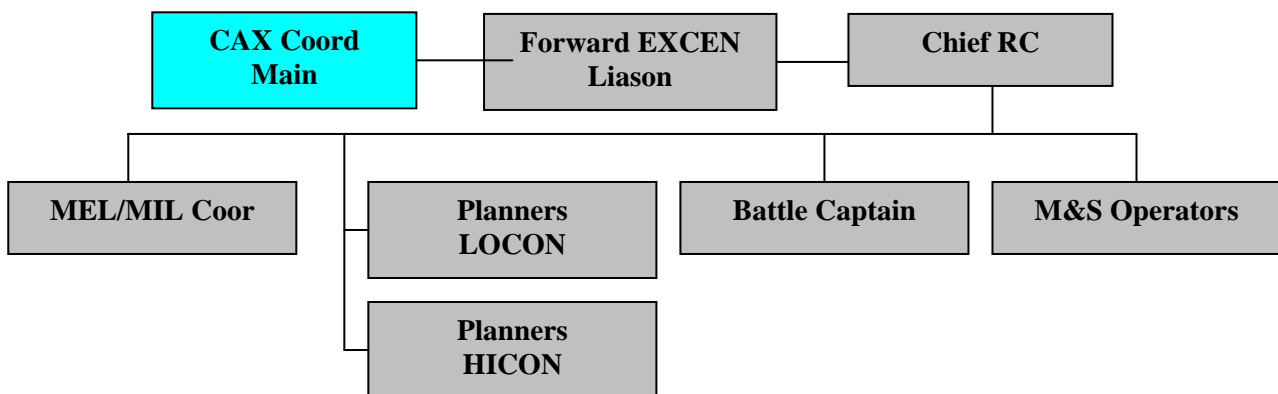
```
┌──────────────┐   ┌──────────────┐   ┌──────────────┐
│  CAX Coord   │───│Forward EXCEN │───│   Chief RC   │
│     Main     │   │   Liason     │   └──────────────┘
└──────────────┘   └──────────────┘
   ┌────────────────┬──────────┴──────────┬────────────────┐
┌──────────────┐  ┌──────────────┐  ┌──────────────┐  ┌──────────────┐
│ MEL/MIL Coor │  │   Planners   │  │Battle Captain│  │ M&S Operators│
└──────────────┘  │    LOCON     │  └──────────────┘  └──────────────┘
                  └──────────────┘
                  ┌──────────────┐
                  │   Planners   │
                  │    HICON     │
                  └──────────────┘
```

Figure 25 Detached RC Model.

4.0   CONCLUSION

The NATO Project Snow Leopard will provide NATO with an integrated LVC environment. Initially a multi resolution simulation capability in the form of a JTLS and JCATS federation will be deployed in JWC and JFTC. This HLA federation is called NATO Training Federation (NTF) and will form a basis for a larger federation where nations can also join by using their command and control systems, simulation systems or terminal workstations. This concept introduces new challenges and requirements for modifications in the exercise control (EXCON) structure. In the current form an EXCON Centre (EXCEN) is a centralized organization. In multi resolution exercises EXCEN should have multiple parts deployed remote sites. We foresee three types of EXCEN, namely main EXCEN, extended EXCEN and forward EXCEN, located in JWC, JFTC and nations respectively.