Live-Virtual Interoperability in Large Flag Exercises

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Outline

- Problem Statement
- Frisian Flag ‘23 LVC Experiment
- Functional and technical realization
- A conceptual model for LVC integration
The need for 5th generation high-end training

• Current day-to-day training is lacking capabilities to do high-end 5th generation training
  ▪ Geopolitical situation increases the likelihood of near-peer threats
  ▪ 5th generation platform offer capabilities to counter such threats
  ▪ However, effective team work in complex missions is required
  ▪ The ability to train such missions is limited by available platforms, training areas and facilities, and personnel

• Complex missions, at scale, can be trained during Large Scale Exercises. But these are costly and logistically challenging to organize.
LVC to enhance day-to-day training

- **Live Virtual Constructive (LVC) can enhance training**
  - Virtual and constructive elements increase the scale of missions
  - Less reliance on scarce platforms
  - Reduced live flight hours reduces cost

- **Some 5th gen platforms already have Embedded Training**
  - Live – Constructive to enrich scenarios
  - Limited to flight (4-ship)
Where is the LVC silver bullet?

• **In practice LVC is still rarely applied structurally**
  ▪ LVC environments are still difficult to achieve
  ▪ Multitude of different (closed) protocols, few common standards for (training) data links
  ▪ Technical hurdles around integration, fair-fight

• **NLR is conducting an Air LVC research programme**

• **We had the opportunity to experiment with LVC during Frisian Flag 2023**
Frisian Flag 2023

- Frisian Flag is a recurring Large Scale Exercise in The Netherlands
  - Organized at Leeuwarden Air base for two weeks (October ’23)
  - Participants from NLD, BEL, DEN, UKR, USA, FIN...
  - 4th and 5th generation platforms, occasional helicopters, SOF, and frigates
  - OCA, DCA mission sets (SEAD, AI, NEO)
Enhancing the exercise with LVC

- **Add LVC entities to enhance the scenario for the live participants**

- **Work with available interactions (radio and Tactical Data Link)**

- **Well chosen scenario role**
  - Technical LVC issues may not hamper the Live Exercise
  - LVC entities not visible on all live sensors taken into account
## Experiment Integration Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Interaction</th>
<th>Risk</th>
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</thead>
</table>
| 1     | - Blue L & V share location via TDL  
       | - Blue L & V communicate via radio  
       | - Blue V can participate in mass debrief (position and shot log) | Low |
| 2     | - Blue V received red surveillance picture  
       | - Blue V configured with representative Mission Data File | Low |
| 3     | - Blue V can share sensor data with Blue L via TDL  
       | - Blue V configured with realistic weapon models | Medium |
| 4     | - L entities represented in V environment  
       | - C ground threats to enrich the L environment | Medium |
| 5     | - Use of TDL mission assignment and free text between Blue L and V | Medium |
| 6     | - Increased fidelity for sensors and weapons to improve training value for V | High |
Impression

source: defensie.nl
LVC experiment results

- Virtual entity was integrated part of exercise
  - Pilot participated in planning, briefing and debriefing normally
  - Role in scenario grew once shown LVC worked

- Limited LVC interactions can already enhance the training value

- Integration level 4 was achieved

- Lot of positive exposure for LVC concept with LSE participants
Maturing the capability

- **Robust radio communication**
  - Increased range
  - Support for multiple frequencies, to be operated from within the simulator
- **Permanent TDL connection**
  - Could be as simple as a JREAP connection
- **Incorporate into TDL network design**
  - Analyse all required interactions, adapt design to fit the need
  - Allocate room for multiple simulators
- **Increase training value for virtual players**
  - Expand role in missions
  - Improve interactions between LVC entities
- **Reduced personnel footprint**
Overcoming non-uniform interoperability

- Multitude of protocols / methods / technologies with which LVC integration can be achieved
  - TDL
  - Simulation Data Distribution technologies / Simulation Protocols
  - Training pods

- It is unlikely that there will be standardisation on this level
  - Different problem domains (e.g. TDL vs. simulation)
  - Proprietary solutions (pods)
  - Life-span of current solutions, and cost of integrating newer solutions in existing platforms
Exploring a conceptual model for LVC integration

• Let’s accept heterogeneity and define mappings between solutions

• Requirements – what data needs to be exchanged?
  ▪ Positional data of platforms: reasonable real-time update rate
  ▪ Sensor information (tracks): recurring, lower update rate
  ▪ Weapon Status: locking, firing, detonating...

• Data flow types
  ▪ Continuous update-based streams
  ▪ Conditional update-based streams
  ▪ One-time, independent events
Exploring a conceptual model for LVC integration

<table>
<thead>
<tr>
<th>Protocol and data</th>
<th>Data flow type</th>
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<tbody>
<tr>
<td>DIS Entity State PDU</td>
<td>Continuous stream</td>
<td>Continuous stream</td>
<td>Link-16 PPLI message</td>
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<tr>
<td>DIS Entity State PDU</td>
<td>Continuous stream</td>
<td>Conditional stream</td>
<td>Link-16 Surveillance track</td>
</tr>
<tr>
<td>DIS EE PDU track list</td>
<td>Conditional stream</td>
<td>Conditional stream</td>
<td>Link-16 Target Sorting (lock-line)</td>
</tr>
<tr>
<td>DIS Fire PDU</td>
<td>Independent event</td>
<td>Conditional stream</td>
<td>Link-16 Target Sorting (shot-line)</td>
</tr>
</tbody>
</table>
Conclusions

• LVC with limited interactions already enhances live training missions

• To use in day-to-day training the experimental LVC setup has to be made more robust and easier to operate

• Heterogeneous solutions and mappings between available protocols, methods and technologies will remain the reality in the near future
Simulation Interoperability Standards Organization

“Simulation Interoperability & Reuse through Standards”

Q&A / Discussion