Applying NEC to UAS Operations Using an Evolutionary Approach

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Scope of this work

Connectivity does not automatically provide NEC…, but there is no NEC without connectivity.

An evolutionary approach for the integration of a UCS with ATC and C2 systems is being pursued:

• exploiting the potential of existing technologies
• similarities in civil aviation (SWIM)

Waiting with the development and implementation of functions until the ‘promised’ NEC level becomes available, will unnecessarily delay the moment at which significant operational gains can be realized.
Introduction

- Coherent effects through the effective use of all observation and weapon capabilities
- Coordinated navigation of many entities and local synchronization
Connectivity Benefits

Enhancing default comms

Exchanging planned state data:
- Enhanced conformance monitoring
- Conflict detection functions at ATC

ATC broadcasts of traffic

Datalinking of voice instructions:
- Tactical ATC commands
- Dynamic airspace boundaries
- Retasking events

Sharing new information:
- Detected threats
- Targets of opportunity
# From Connectivity to NEC

## NEC Levels:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Isolated</td>
<td>Exchange of information through conventional means</td>
</tr>
<tr>
<td>2</td>
<td>De-conflicted</td>
<td>Limited coordination,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No common picture of the situation</td>
</tr>
<tr>
<td>3</td>
<td>Coordination</td>
<td>Coherent and efficient communication,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information Sharing,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Common picture of the situation</td>
</tr>
<tr>
<td>4</td>
<td>Integration</td>
<td>Integrated, coherent and consistent cooperation,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficient, interactive planning and execution</td>
</tr>
<tr>
<td>5</td>
<td>Coherent effects</td>
<td>Effective use of all observation and weapon capabilities</td>
</tr>
</tbody>
</table>
UCS Connectivity Options

1. (NEC L1)
   - No connectivity

2. (NEC L2)
   - Connectivity, but no interaction
   - Push/pull data

3. (NEC L3-5)
   - Interact with functions

- Interact with functions
Development of NEC functions

Research UCS – Baseline system (Config. 0):

- Voice vectoring
- Real-time interaction with the route (definition / modification)
- Implementation of the selected route
Connectivity of the UCS with ATC

Airspace Integration

Graphics Engine

Route Visualization

Route Selection / Generation

Route Buffer

GUI

Interpreter

Route Manager

UAV CTRL Uplink

UAV Downlink

Ownship State

Network Interface for Route Exchange

Network Interface for Ownship State

[A]

[B]

[E1]

Network
Connectivity of the UCS with C2

Faster OODA loop

Route / Area Visualization
Route Selection / Generation
Route / Area Buffer
Graphics Engine

GUI [F1]
Interpreter

Route Manager
UAV CTRL Uplink
UAV Downlink

Network Interface for Tactical Data Exchange
Network Interface for Ownship State

Connectivity of the UCS with C2
6/24/2010
UAV CTRL
Uplink
UAV
Downlink
Route
Manager
Route Selection /
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Graphics
Engine
GUI [F1]
Interpreter
Route Manager
UAV CTRL
Uplink
UAV Downlink
Network Interface for
Tactical Data Exchange
Network Interface for
Ownship State

Faster OODA loop

Network
Situation without Datalink

Radio communication:
- ATC and C2 commands
- dynamic airspace properties (maneuver area's, restricted airspace etc.)
- UAV trajectory
Desired Connectivity

UAV radar returns

RADAR/ Simulated RADAR

UAV plot

Traffic plots

MASE

C2

ATC

- ATC and C2 commands
- dynamic airspace properties

voice

Radio communication

data link

UAV trajectory information
How to get there?

In the near term we must live with the separate systems we have today. But we can take steps, using modeling and simulation, to test and tune future integration.

The results of such an approach contribute to:
- the definition of a roadmap for the functions that will benefit from an increase in connectivity (e.g. in terms of bandwidth, security, availability, integrity);
- refine the requirements for the final SWIM environment.

In this way, an evolutionary, spiral-based approach to NEC can be achieved.
Simulation Environment

- Linkage
- Wrapper
- Filler

UCS

- DIS to RSRP
- RSRP to DIS
- Traffic plots simulated by the UCS

RADAR/Simulated RADAR

MASE

- C2
- ATC

UAV Simulation

- Pre-loaded UAV routes
- Pre-loaded C2 and ATC commands

Radio communication

Traffic plots

Pre-loaded UAV routes and ATC commands

DIS

RSRP

Traffic plots

Voice

Pre-loaded C2 and ATC commands
Simulation Studies & Demonstrations

- Airspace integration;
- ISTAR & BDA;
- Time-sensitive re-tasking.

- Chief of Royal Netherlands
- Air Force Command
- Military Air Traffic Control Centre
- Defense Materiel Organization
- C2 Knowledge Centre (Army, Navy, Air Force)
- Defense Research & Development
Simulation Studies & Demonstrations

1. Automatic Taxiing & Take-Off
2. Traffic Deconfliction (3x)
   - ATC controller
   - UAV controller (ACAS trigger)
   - ACAS automatic
3. Target Acquisition & BDA
4. Time Sensitive Re-tasking
5. Lost Comms procedure
6. Automatic Landing
Simulation Studies & Demonstrations

- Vehicle-Payload Interaction
- Distributed Control
- Geographically Separated Users

Vehicle Operator

Sensor Operator

Synthetic Vision Technology
Standards for the protocols needed to realize the envisioned NEC CONOPS do not yet exist. Also, the current generation C2 systems still has proprietary interfaces.

The increased adherence to standards will reduce the amount of wrappers needed to integrate different, non-standard systems into common network.

Information sharing in itself will only allow NEC L3 to be reached. L4: integrated and coherent cooperation, requires the development of concepts defining how multiple users interact with the data.

Achieving NEC L5 goes beyond the integration of a UCS with C2 and ATC and requires a consideration of the overall system of which all these elements are part.

Clearly, these capabilities will not just ‘happen’. Focused research is needed to identify possibilities and explore them.
An evolutionary approach for the integration of a UCS with ATC and C2 systems is being pursued:

- exploiting the potential of existing technologies;
- similarities in civil aviation (SWIM).

The results of such an approach contribute to:

- the definition of a roadmap for the functions that will benefit from an increase in connectivity (e.g. in terms of bandwidth, security, availability, integrity);
- refine the requirements for the final SWIM environment.

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Summary & Conclusions

The concepts discussed in this work are not new, but the implementation of the integrated simulation environment and the subsequent use to explore these concepts is still quite rare.

It has been demonstrated how to enable NEC without having to do “big bang” development where the entire network is realized in one spiral, development cycle, or acquisition.

The more implementations, scenarios, and domains that embrace this approach, the more likely it is that we’ll see more NECs available on the shelf, to everyone’s benefit.

Waiting with the development and implementation of functions until the ‘promised’ NEC level becomes available, will unnecessarily delay the moment at which significant operational gains can be realized.
Thank You

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