FFI Forsvarets forskningsinstitutt

Ad hoc Organisation of Distributed Picture Compilation and Support for Situation Awareness in Network Based Defence

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An Exploratory Experiment

10th ICCRTS

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Introduction

- Exploratory experiment (“Thinking outside the box”)
- Conducted during the NATO exercise Battle Griffin in February/March 2005
  - Part of the Norwegian Armed Forces Concept Development & Experimentation (CDE) program
- Scope:
  - Situation awareness
  - Information sharing
  - Collaboration

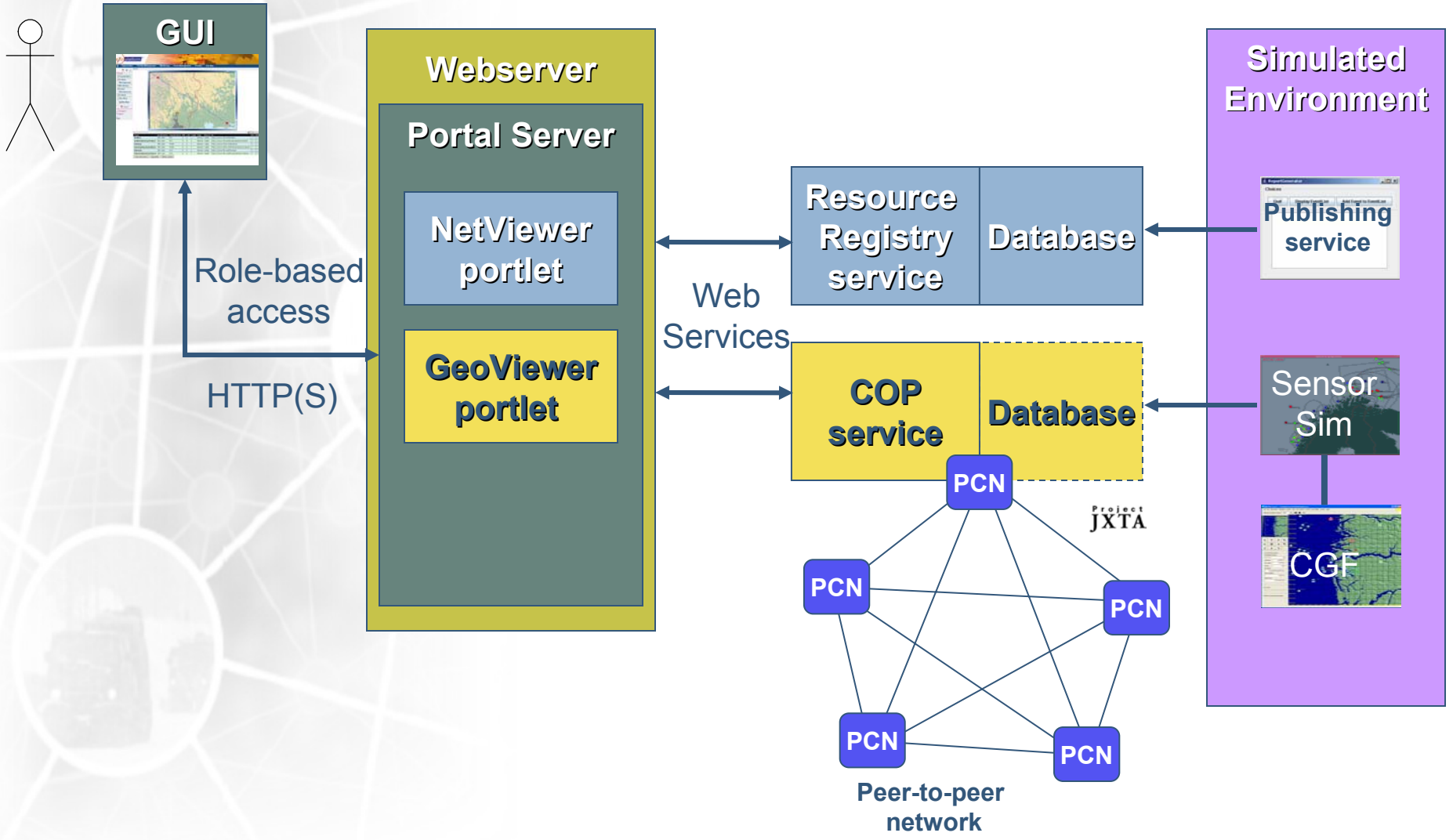
Aim and Objectives

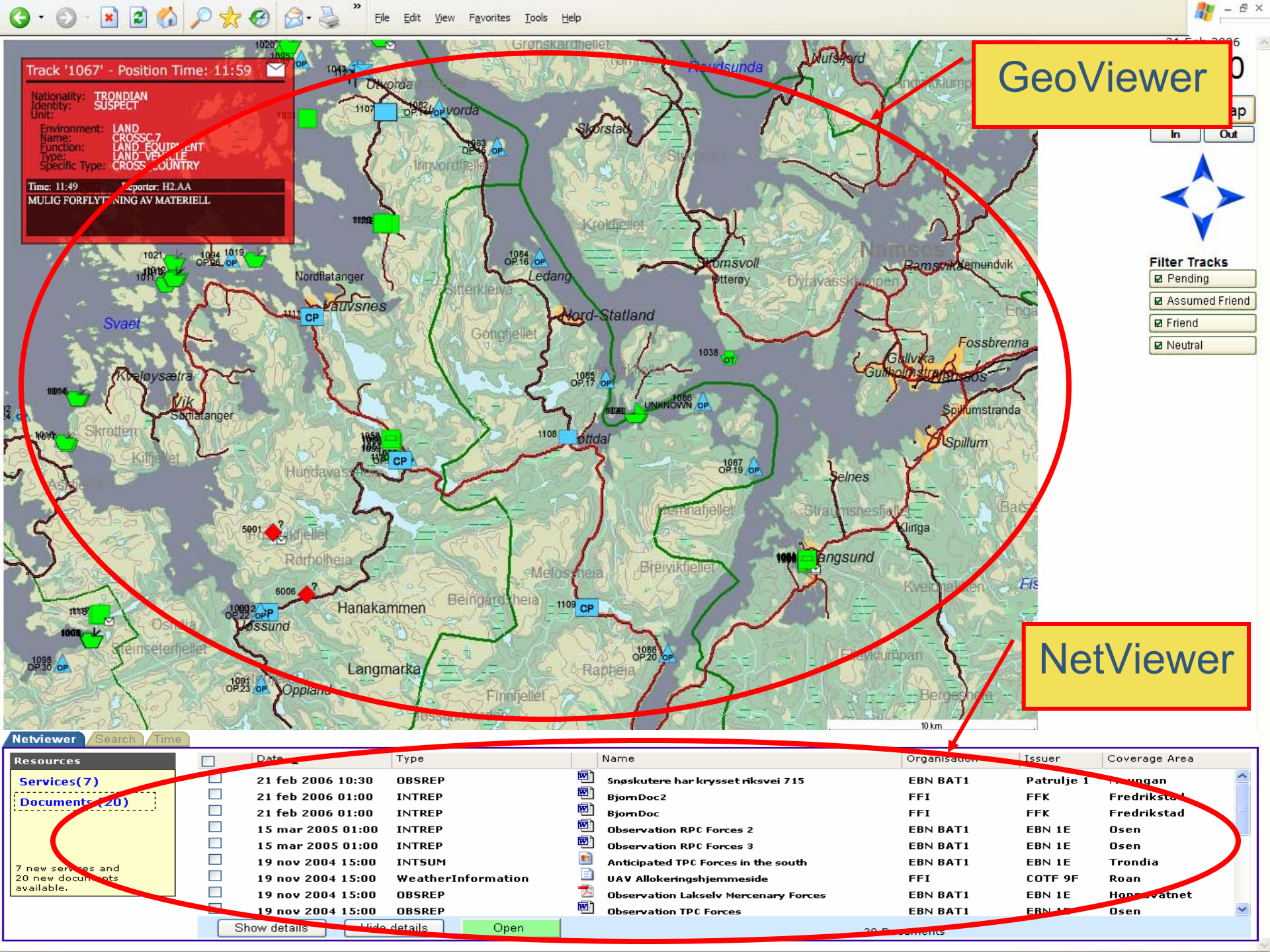
- Explore the operational value of selected technological solutions for flexible information sharing in Network Based Defence (NBD):
  - Ad hoc organisation of information flow (flexible information sharing) applied to the distributed compilation of a common operational picture (COP)
  - New ways of collaboration (peer-to-peer horizontal collaboration) between military entities on tactical C2-level
- Explore how new technology and new ways of collaboration affected situation awareness (SA) both on individual and team level

The Experiment Design

- Designed according to essential NBD-ideas:
  - Resources belong to the network rather than the platform
  - Post & pull (i.e. from push to pull-oriented supply chain)
  - Flat organisation (peer-to-peer), horizontal collaboration
  - Focus on the low tactical level
- An operational and technical setting was developed together with a military response mission scenario
- Use of a command and control demonstrator developed at FFI
  - Utilizing Commercial Off The Shelf technologies and open standards (Web Services and peer-to-peer technologies, among others)
- All elements in the situation were simulated

Technology Demonstrator




GeoViewer
NetViewer
Track '1067' - Position Time: 11:59
Nationality: TRONDIAN
Identity: SUSPECT
Unit:
Environment: LAND
Name: CROSSC.7
Function: LAND_EQUIPMENT
Type: LAND_VEHICLE
Specific Type: CROSS_COUNTRY
Time: 11:49
Reporter: H2.AA
MULIG FORFLYTNING AV MATERIELL
Filter Tracks
Pending
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Netviewer
Search
Time
Resources
Services(7)
Documents(20)
7 new services and 20 new documents available.
Date
Type
Name
Organisation
Issuer
Coverage Area
21 feb 2006 10:30 OBSREP Snøskutere har krysset riksvei 715 EBN BAT1 Patrulje 1
21 feb 2006 01:00 INTREP BjornDoc2 FFI FFK Fredrikstad
21 feb 2006 01:00 INTREP BjornDoc FFI FFK Fredrikstad
15 mar 2005 01:00 INTREP Observation RPC Forces 2 EBN BAT1 EBN 1E Osen
15 mar 2005 01:00 INTREP Observation RPC Forces 3 EBN BAT1 EBN 1E Osen
19 nov 2004 15:00 INTSUM Anticipated TPC Forces in the south EBN BAT1 EBN 1E Trondia
19 nov 2004 15:00 WeatherInformation UAV Allokeringshjemmeside FFI COTF 9F Roan
19 nov 2004 15:00 OBSREP Observation Lakselv Mercenary Forces EBN BAT1 EBN 1E
19 nov 2004 15:00 OBSREP Observation TPC Forces EBN BAT1 EBN 1E Osen
Show details
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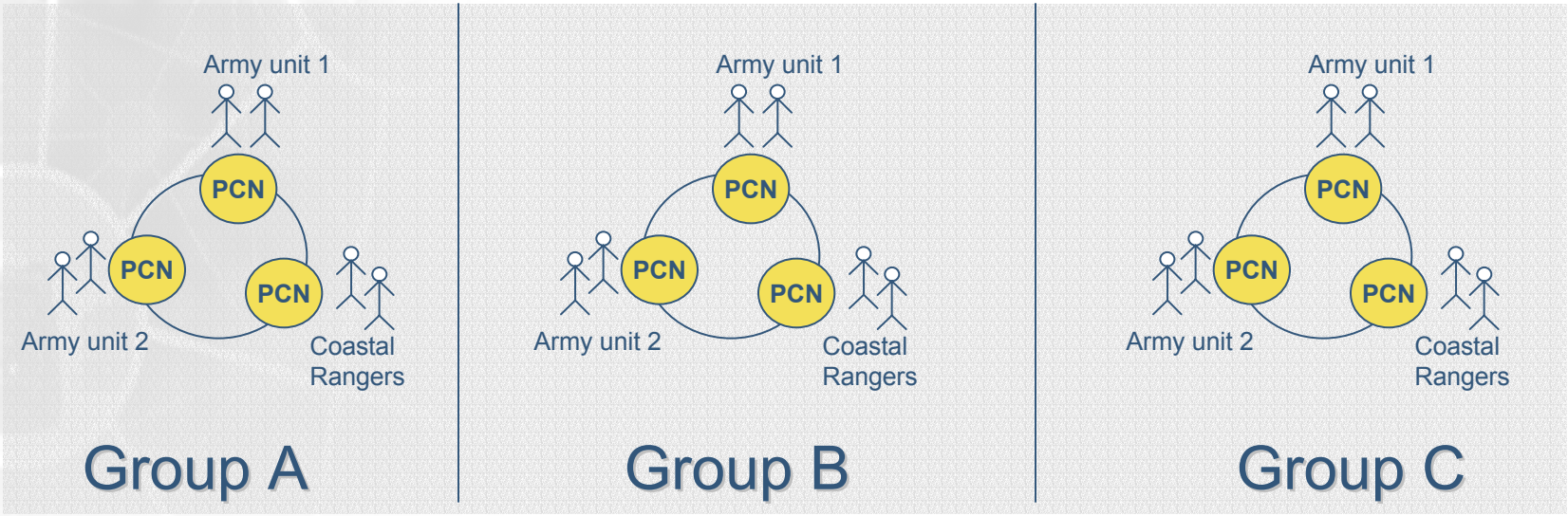
Open

Experimental set-up

- Total of 18 subjects (intelligence officers/personnel)
- Task: Collaborate in building a COP involving land and sea entities in a escalating military conflict situation
- The aim for the teams was to develop a situation awareness of the whole operational area
- Decentralized organization (non layered) at tactical level



Experimental set-up, cont.

- All teams were initially given the same information
- By linking into the other teams' picture compilation nodes they also shared each others information streams
- The scenario was played at a speed of 4 times real time
- The experiment was run 3 times, one for each group
- Each session lasted 4 hours, including introduction, on site training and SA measurements

Methodology - Measurements

- **Situation Global Assessment Technique (SAGAT) - 3 levels of SA**:
  - *Level 1*: Perception of relevant elements in the situation
  - *Level 2*: Comprehension of the meaning of elements of the situation
  - *Level 3*: Projection of the status of elements in the immediate future
- **Situation Awareness Rating Technique (SART)**
  - *Demand-factor*: The demand on cognitive resources from the context, I.e. the instability, complexity and variability of the situation
  - *Supply-factor*: The supply of cognitive recourses, I.e. arousal, concentration of attention, division of attention and spare mental capacity
  - *Understanding-factor*:The quality and quantity of information, degree of familiarity with the situation.
- **Teamwork Assessment Measure (process)**
  - *Communication*: The ability to provide important information to others
  - *Back-up*: Ability to be aware of each other's workload build-up and react to adjust division of task responsibilities to redistribute workload
  - *Coordination/Information exchange*: The ability to pass critical information to others (without asking for it), thereby enabling them to accomplish their tasks
- **Perceived Technology Support**

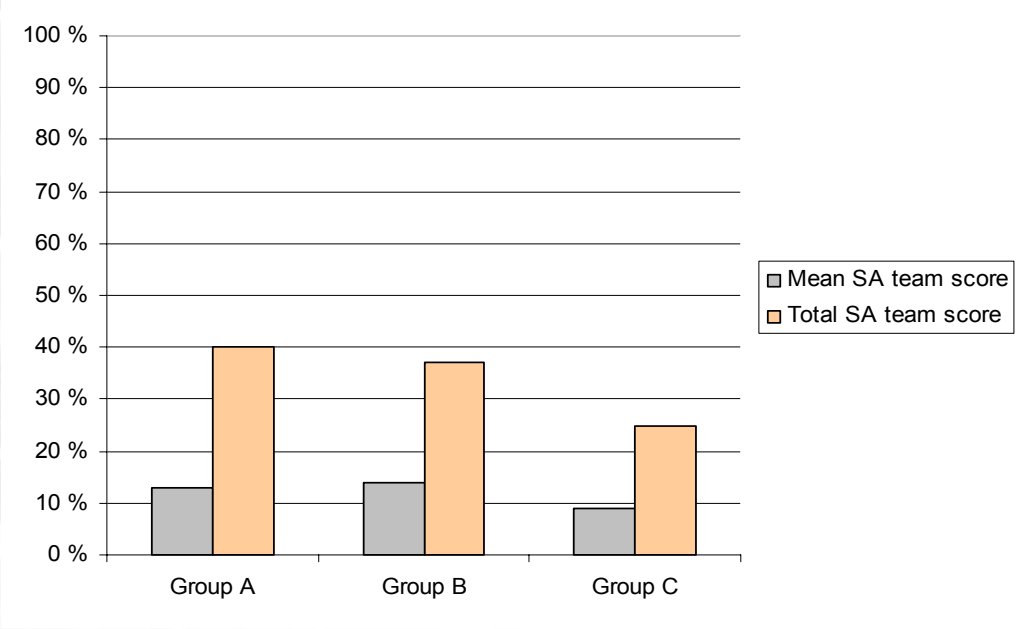
Main Results

Individual SA

- Overconfidence towards their own SA (SART)
  - In average aware of only 12% of the elements in the situation (SAGAT, SA level 1)
- Better in understanding the situation (SA level 2) and predict the situation (SA level 3)
  - Intention of non-compliant forces: 62% correct (SAGAT)
  - Predict actions: 63% correct (SAGAT)
  - Picking the right place of attack: 27% correct (SAGAT)
- The participants rated their arousal above average in the situation
- The quality of the information they acquired was rated as below average

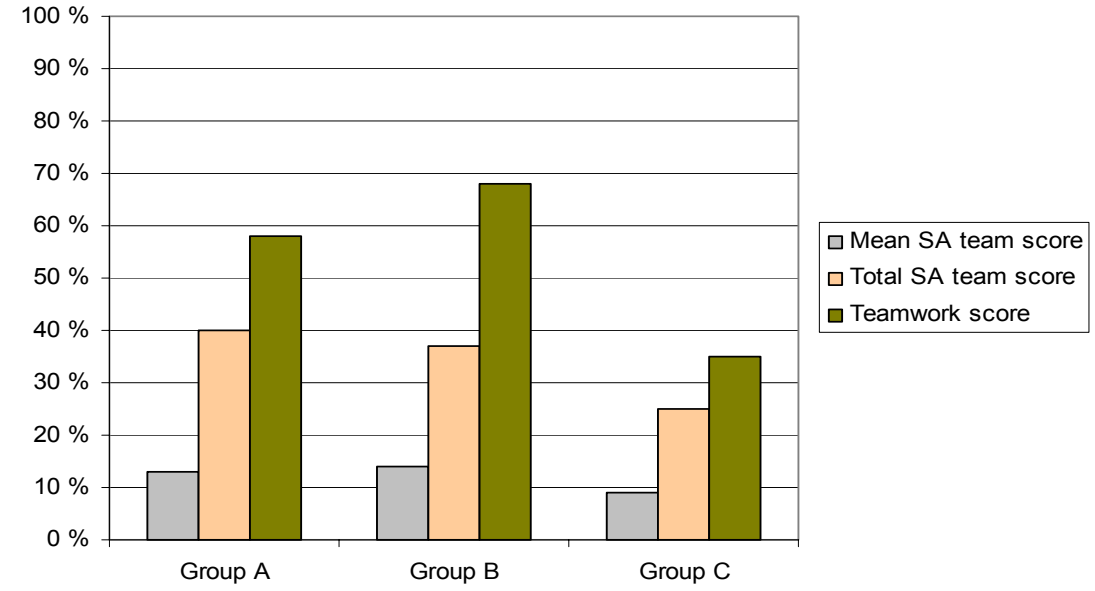
Team SA

- Team SA level 1:
  - Group A: Mean 13%, Total SA 40% correct
  - Group B: Mean 14%, Total SA 37% correct
  - Group C: Mean 9% , Total SA 25% correct
- Insufficient analysis of individual and team SA level 2 and 3



Teamwork

- The teams differed in teamwork behaviour
- Group C had significantly lower Teamwork score that the other groups (Group A 58%, Group B 68%, Group C 35%)
- Group C differed significantly from the other groups by performing less coordination and communication activities



Comparison of team SA and teamwork

Perceived Technology Support

- In general: Good SA correlated to positive ratings of the technology demonstrator
- “GeoViewer” (collective sharing of situation picture information):
  - Moderate improvement in problem solving (easier, faster and more effective)
- NetViewer:
  - Moderate improvement in problem solving (easier, faster and more effective), but contribute to increased complexity
- Chat (mIRC/JoinMe) :
  - Good SA related to positive experiences with chat

Results show that…

- SA correlated positively on all technology support variables, i.e. good SA is related to positive evaluations of the demonstrator and chat
- Generally, the participants had some overconfidence in their individual SA.
  - The participants were in average aware of 12 % of the elements in the situation.
- Despite low awareness of elements, the participants were able to understand the situation correctly and select right projections to a larger extent
- The demonstrator gave insufficient support to SA level 1 (e.g. poor map- and search functionality)

Results show that… cont.

- Due to small samples it was difficult to do any qualified analysis on team SA and shared SA
- However, when comparing the individual SA, team SA and the teamwork scores, a pattern emerged:
  - A tendency towards a positive relation between collaboration (facilitated by the demonstrator) and good SA

Conclusions

- As an exploratory experiment the experiment presented has provided few clear answers, yet they are in accordance with our expectations
- Our main conclusion is that the results support our view that:
  - New technological solutions *can* increase the ability to establish a COP in situations where dynamic configuration of forces is necessary. This can increase shared situational awareness
  - The processes of picture compilation should be tailored to get the most operational value out of the new technological possibilities
- Much has been learned about the possibilities and problems of measuring situation awareness in an operational setting
- We have gained more insight into the complex interplay between the organisational, procedural, human and technological elements that constitute technology-supported collaboration in military operations
- Several positively interesting observations and questions for further studies have been identified

The End

NetViewer

- NbF-challenges / operator needs:
  - Keep an overview of available resources
  - Find and select relevant resources to utilize
  - Make own resources available in the network
- Enabled by use of a Resource Registry (RR)
  - Implemented as a web service
  - Contained metadata about the resources available in the network
- NetViewer utilized and displayed metadata from RR
  - Implemented as a portlet
  - Provide sufficient information to operators for selecting which resources to utilize and which not to utilize
  - In this experiment the focus was on the two first challenges

“Ad-hoc organisation”

- Assertion:
  - The concept of “Ad hoc organisation of information flow” will increase information access and sharing in a more flexible and timely manner than existing systems provide today

- Dynamic linking of available resources in the network
  - Military units can “plug in” to the network and offer their resources to others – on a “come and go” basis
- Distributed collaborative compilation of a Common Operational Picture
  - contributions to picture compilation: Networked actors utilising available sources when needed in a flexible manner
- Access to information based on the user’s needs
  - Ad-hoc set-up of the information flow, when needed

Ad-hoc organisation

Added Value

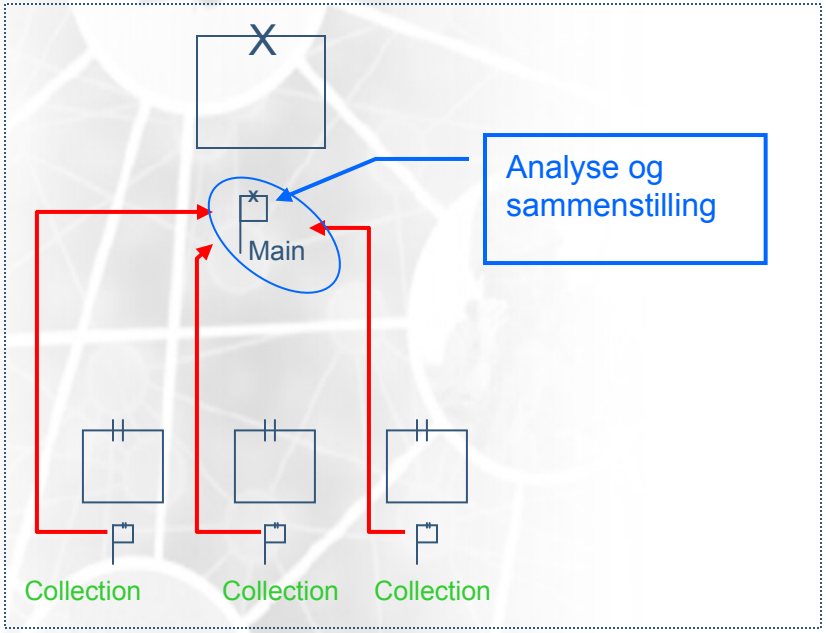
Dynamic linking of resources in the network → Resources are made **available** to all actors in the network - on-the-fly

Distributed collaborative compilation of a Common Operational Picture → Ad-hoc **contributions** to picture compilation: Networked actors utilising available sources when needed in a **flexible** manner

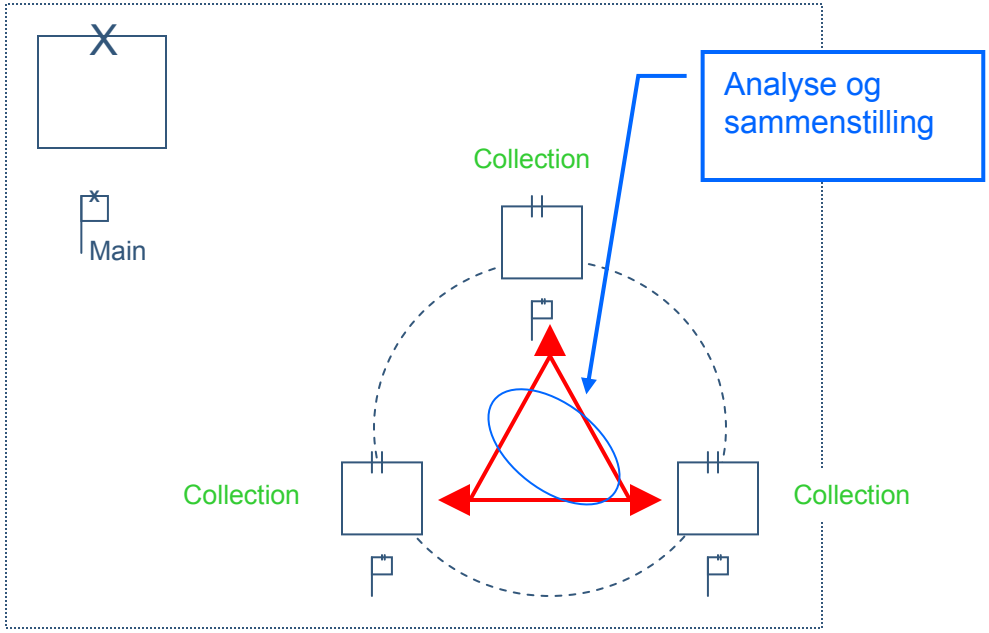
Information access based on user needs → Information can be requested in a format tailored for the user, based on the users needs

Sensors, effectors and picture compilation nodes will be considered as common resources, not as the property of a specific platform. They will be utilised on an ad-hoc basis, based on the users' needs.

Horizontal Collaboration



Existing organising



Our organising