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# Peer-to-Peer Technology

## An Enabler for Command and Control Information Systems in a Network Based Defence?

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# Outline

- Motivation
- Today's C2IS
- Network Based Defence C2IS
- Peer-to-peer Technology
- Why peer-to-peer technology?
- Picture Compilation Demonstrator
- Blue Game 2004 Participation
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# Motivation

- Towards a Network Based Defence \*)
- Based on:
  - Dynamic composition of capacity components
  - Shared situation awareness
- All members of a force should have the same, consistent information available to them - also in highly dynamic situations
- But:
  - variety of different equipment (e.g. PDA with low bandwidth)
  - different information needs (customisation is needed)
- The challenge of (semi-)automatically compiling and distributing a Common Operational Picture in a dynamic environment with different user equipment and network connections

*\*) Network Based Defence is the Norwegian adaptation of Network Centric Warfare*



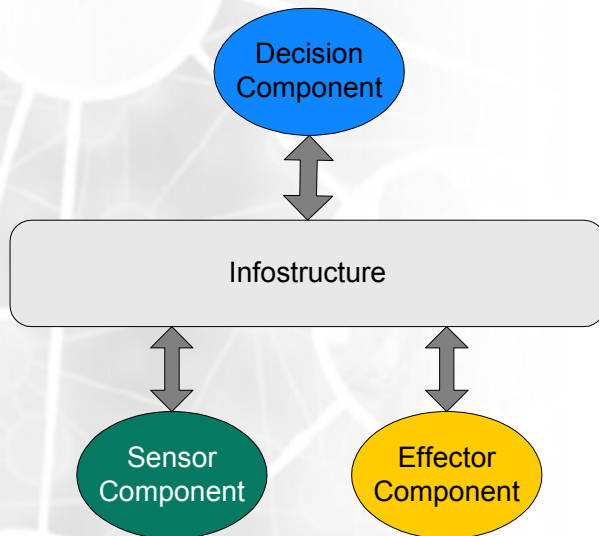
# Today's C2ISs

Today's Command and control systems often:

- Are stovepiped
- Have a highly centralized structure
- Have central processing of information
- Are based on message exchange between sites
- Have a quite static network topology
- Have people administrating network connections
- Are not responsive enough to enable dynamic composition and restructuring of forces



# Network Based Defence C2ISs



## Network Based Defence

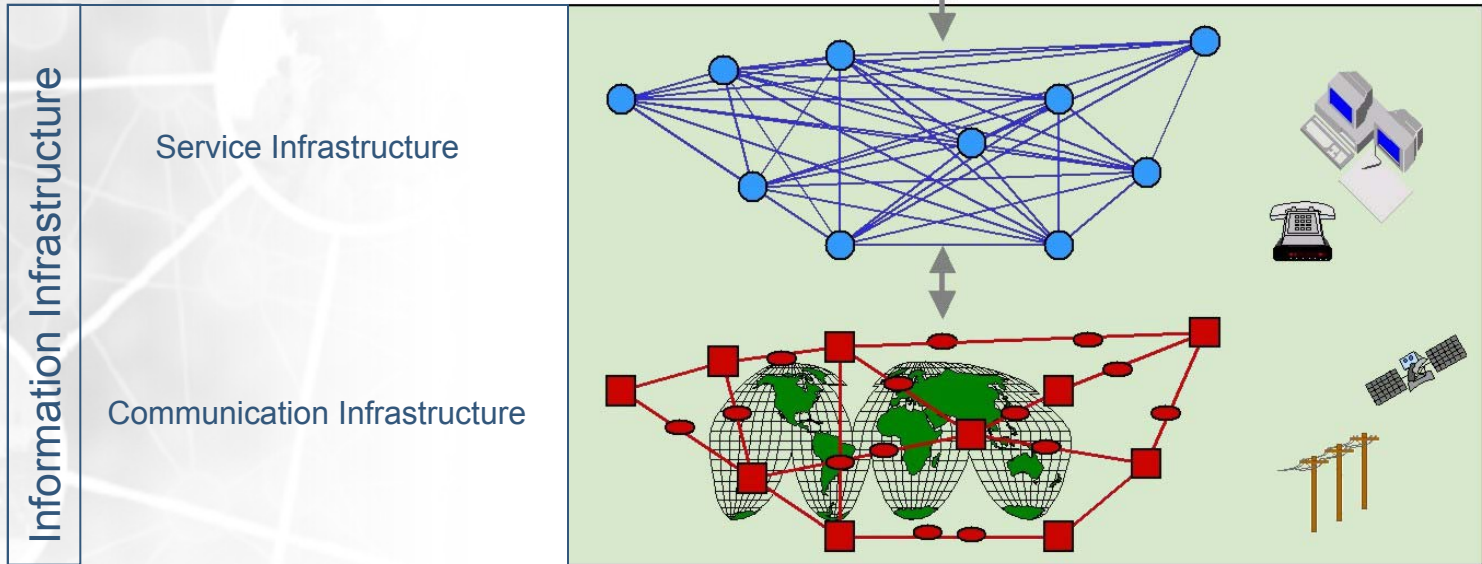
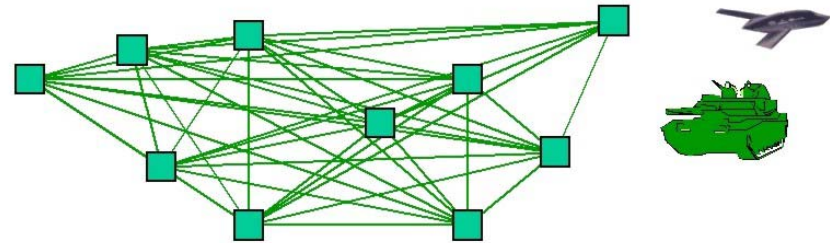
- High-level component model
- Military resources will be decomposed into components offering services
- The Infostructure has to enable discovery of services
- Services should be able to do such discovery as well as publishing their own resources continuously

Therefore, a future C2IS is a service-oriented architecture

# Information Infrastructure and Operational Network



Operational network

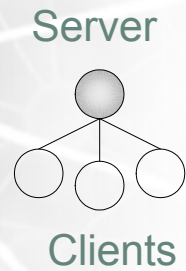




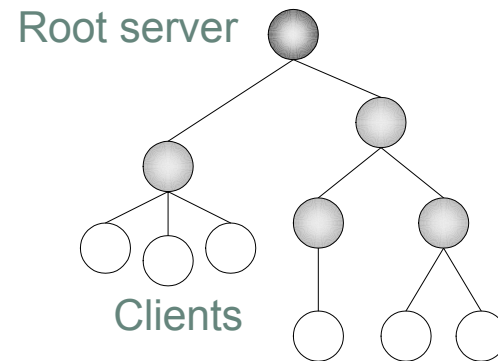
# Peer-to-peer Technology

- Based on “equality”
- User “plugs in to the network to find resources, and/or publishes her own resources for others to utilize”
- Designed to utilize resources (bandwidth, storage capacity, CPU) “at the edge of the network”
- A collaborative system, based on voluntary participation of peers
- Virtual, homogeneous network on top of possibly various communication technologies, networks and platforms
- Does not have to be completely decentralized

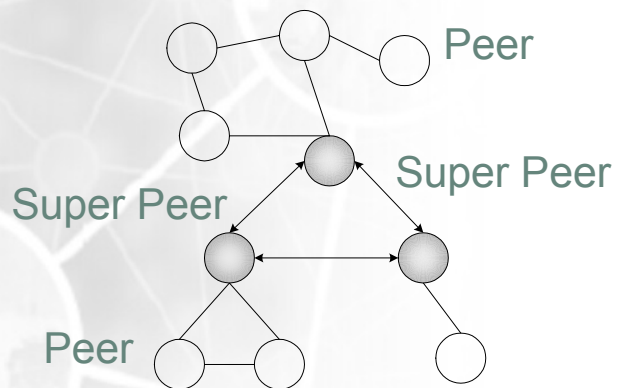
# Topologies



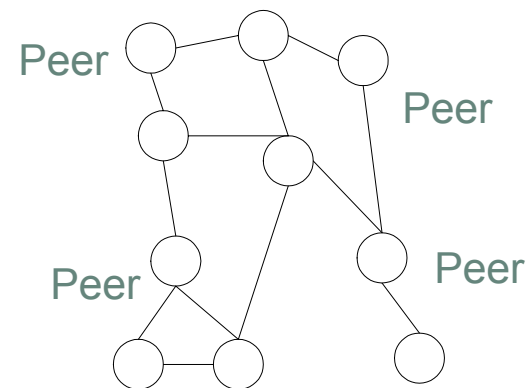
a) Client-server/centralized



b) Hierarchical



c) Hybrid



d) Decentralized





# Why Peer-to-peer Technology?

- **Robust**
  - Often garbage collection
  - Scalable (Napster etc.)
  - Supports network mobility
- **Less administration** (configuration etc.)
  - Services may appear and disappear continuously
  - Topology changes
  - Availability/survivability
  - Fail-over
- **Automatic discovery of services/resources**
  - Can be used as a universal discovery service, integrating different middleware services into the same discovery system
- **Information handling/resource exploitation**
  - Group/room mechanism to avoid information overflow

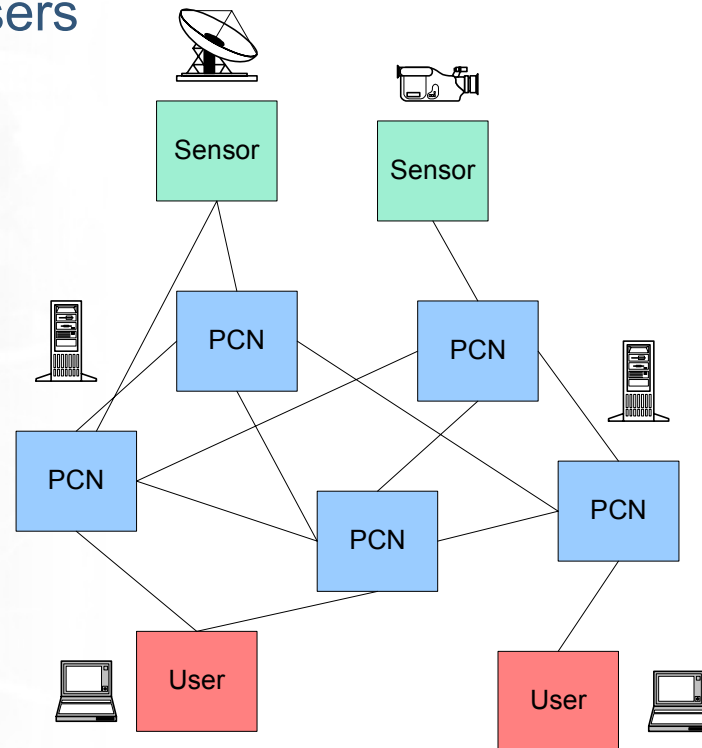


# Why Peer-to-peer Technology? (cont.)

- **Possible applications**
  - Virtual whiteboards
  - Multimedia
  - Instant messaging/Chat
  - Information-/content-sharing applications (Files)
  - Clustered computing
- **Potential problems**
  - Security, needs to be decentralized (web of trust)
  - Total bandwidth consumption higher (but less bottlenecks?)
  - QoS
- **Technologies**
  - We have looked at: Jini, JXTA

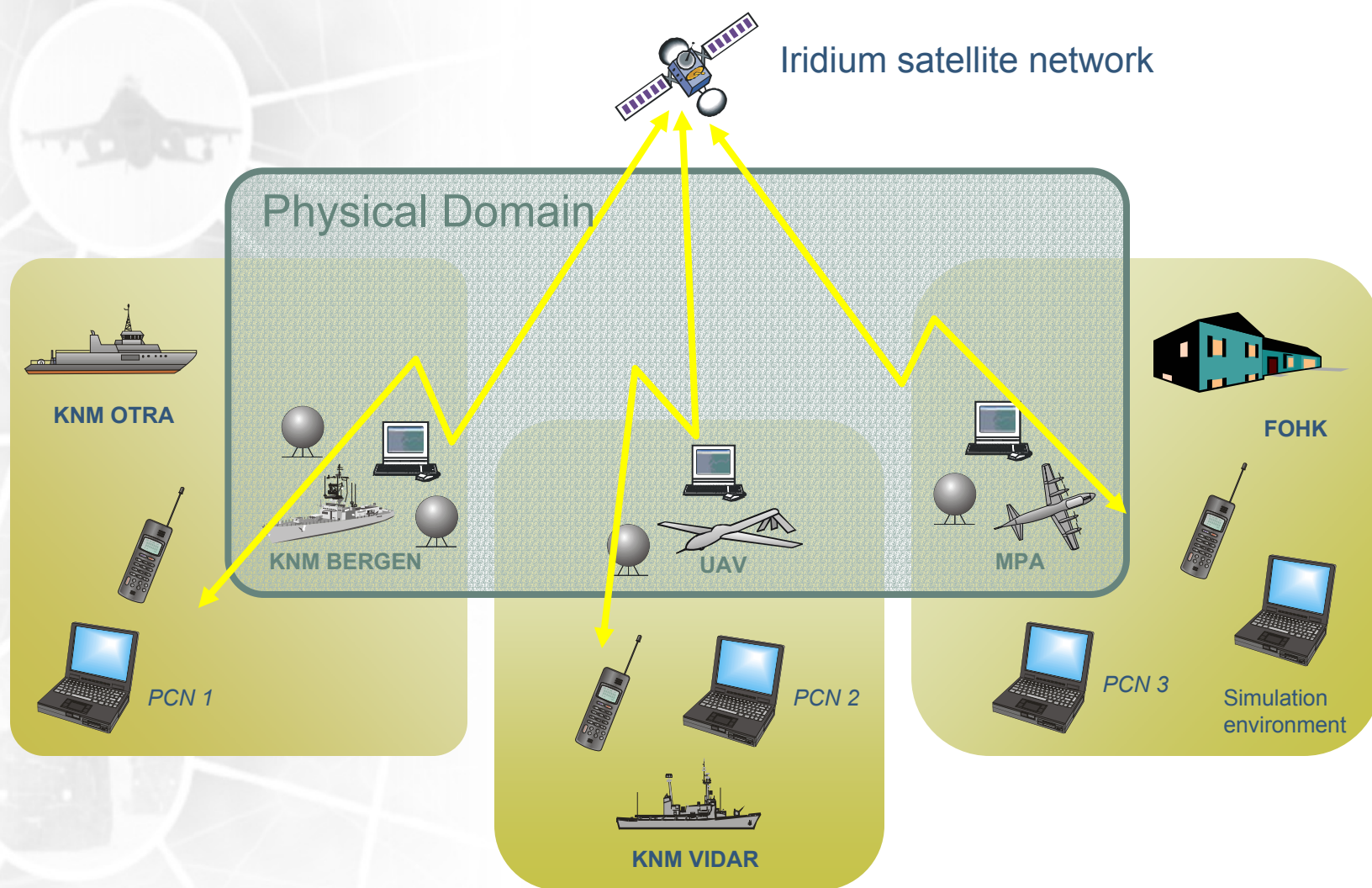
# Distributed situation picture compilation

- A concept for distributed picture compilation is being developed
- Based on Picture Compilation Nodes (PCNs)\*, a kind of agent that gathers information from sensors and other PCNs and delivers this to users



\*) A PCN is referred to as a PPN in the proceedings

# Blue Game 2004 Participation





# Challenges of internet Communication (Blue Game experience)

- A large step from high bandwidth LANs to low bandwidth WANs
- Internet obstacles
  - IP-addressing (dynamic, private/non-routable NAT)
  - Firewalls
- We used the JXTA peer-to-peer framework in a publish and subscribe pattern
  - Lack of bandwidth economy (XML-based)
  - Relay peers very helpful
- Communication services used
  - Iridium Low Orbit Satellite network
  - LAN Connection
  - Mobile telephony (GPRS) was also tested





# Conclusion

- No such thing as a single solution to all distributed computing problems
- Peer-to-peer technology may solve some of the new challenges in future C2IS
- Looks promising, but further work is needed



# Questions?

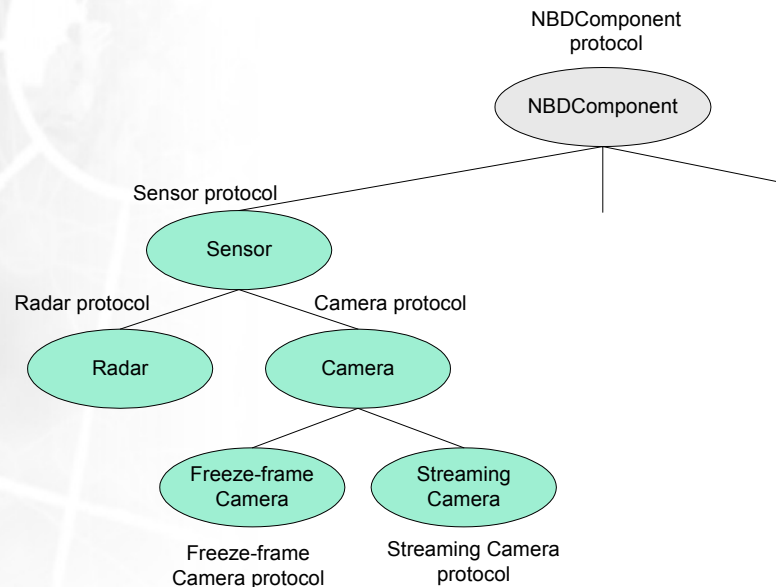
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# Some Thoughts on Efficient Discovery

- Often, a simple search string is not enough (e.g. "Radar")
- Type-subtype relationship -> taxonomy of services and their protocols (message exchange definition)
- Semantics to avoid ambiguity (e.g. the string "Tanker")
- W3C Semantic Web effort combined with p2p discovery?



# Picture Compilation Demonstrator

