Enhanced High Capacity Data Radio (EnHCDR)

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Agenda

> Operational context – typical hierarchal deployment
> EnHCDR built on HCDR heritage
> The power of a MANET
> Summary
Operational Context
Operational Context

Both the UK and US are focusing on the importance of a communications network which enhances the capability of fighting forces

USA - Network Centric Warfare (NCW)
> NCW focuses on the combat power that can be generated from the effective linking or networking of the war fighting enterprise

UK - Network Enabled Capability (NEC)
> To achieve enhanced military effect through the better use of information systems
  • A robustly networked force improves information sharing
  • Information sharing and collaboration improves Shared Situational Awareness (SSA)
  • SSA improves synchronisation and thereby mission effectiveness

The right information... ...in the right place... ...at the right time...
> Nets owned by the command chain
> Messages follow command hierarchy
> Fixed planned routes via radio rebroadcast, radio relays; creates many single points of failure
> Significant planning and user management needed to keep up with the flow of the battle
> Nodes A and B communicate via 5 nets, 6 transmissions and 12 radios – slow, unreliable, inefficient
Self Managing Network

- One large network
- No ownership of sub networks
- Messages follow optimum dynamic route – improves efficiency
- **No single points of failure** – network adapts around unworkable links and attrition
- Reduces the planning and management burden increasing the pace of operations
- Nodes A and B now communicate via 1 transmission

Enhanced HCDR Operational Context

**EnHCDR Unlocks NEC**
The right information... ..in the right place... ..at the right time...

..in real time
Enhanced HCDR
Built on the Heritage of HCDR
HCDR Heritage

HCDR developed for/with the UK MOD
  > 4000 deployed with UK
  > Many deployed with European nations
  > Field proven

Proven to support large scale networks of 120 nodes
  > Advanced ad-hoc networking algorithms - minimise network overheads to maximise user throughput and flexibility
    • self forming
    • self healing
    • self managing with no user intervention required
    • all nodes are equal heads and are elected not pre-defined

  > Efficient IP route forwarding algorithms for use as a transit net

Open interfaces for easy system integration (IPv4, SNMP, IGMP and OSPF)
EnHCDR development – pushing the limits

- EnHCDR developed in response to demand for increased throughput to meet operational needs
- Exploits latest 4G commercial research
  - New physical layer – OFDM used in Wimax and LTE
- Provides significant throughput increase over HCDR without compromising range
- Improved resilience to multipath mobility effects
- Research funded in conjunction with UK MOD (DSTL and BATCIS)

More than 6 fold improvement in user throughput
Achieving an efficient Linear Power Amplifier

OFDM requires a Linear PA which could be very inefficient requiring 1kW to produce just 20W. EnHCDR exploits the latest techniques to overcome this challenge

**Digital PreDistortion (DPD)**

> The characteristics of the amplifier are continually monitored for each frequency and power level

> The output is combined with an inverse of the PA’s characteristics to produce the desired signal at the antenna

> The Amplifier can be used closer to its compression point and therefore increase its efficiency

> EnHCDR has the first frequency hopping DPD solution

**Envelope Tracking**

> OFDM is not constant amplitude and has a high Peak to Average Power Ratio

> Energy is wasted when all the supply voltage is not used

> Exasperated by the extra headroom required for the High PAPR

> Envelope Tracking matches the supply voltage to the transmitted signal – saving energy
**EnHCDR System Overview**

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<thead>
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<th>Architecture</th>
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<tr>
<td></td>
<td>IP based MANET Radio – very fast convergence</td>
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<tr>
<td>Internal network</td>
<td>Optimised for tactical mobile networking</td>
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<tr>
<td>Scalability</td>
<td>Advanced Networking algorithms tested at 63 and 120 nodes</td>
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<td>Throughput</td>
<td>**Narrowband</td>
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<td></td>
<td>Point to Point: &gt; 1 Mbps</td>
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<td>Network: &gt; 2.5 Mbps</td>
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<td>Spectral Occupancy</td>
<td>3 Channels @ 650 kHz</td>
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<td>Open Interfaces</td>
<td>IPv4, OSPF V2, IGMP Multicast, SNMP</td>
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<td>Planning Range</td>
<td>8 -12 km vehicle antenna (18 – 22km on recent trials)</td>
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<tr>
<td>Frequency Range</td>
<td>225 – 400 MHz</td>
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<td>RF Power</td>
<td>Adaptive up to 20 W</td>
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The Power of a MANET
Scale Is Everything – An N node network has \((N-1)^2\) connections

Tested at scale: 63 EnHCDR in a configurable environment

A 63 node all informed network – optimised for efficient operation

Enhanced HCDR The Power of a MANET
63 Node 15 Hop Network String Formation

Each group of 4 radios can only communicate with adjacent groups all other traffic must go via intermediaries (e.g. border protection over 300km)
Network took 10 minutes to form and optimise from switch on with no operator intervention or special planning
In Summary

EnHCDR provides sufficient user throughput to enable:
- Shared Situation Awareness
- Image and video distribution
- Database distribution
- Voice over IP
- Messaging services

EnHCDR’s advanced, resilient networking algorithms reduce the planning and management burden.

EnHCDR removes single points of failure from the battlefield.