

*Data Replication in the
CNR Environment:*

*The Harsh Reality of a Harsh
Communications Environment*

presented by

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Report Documentation Page

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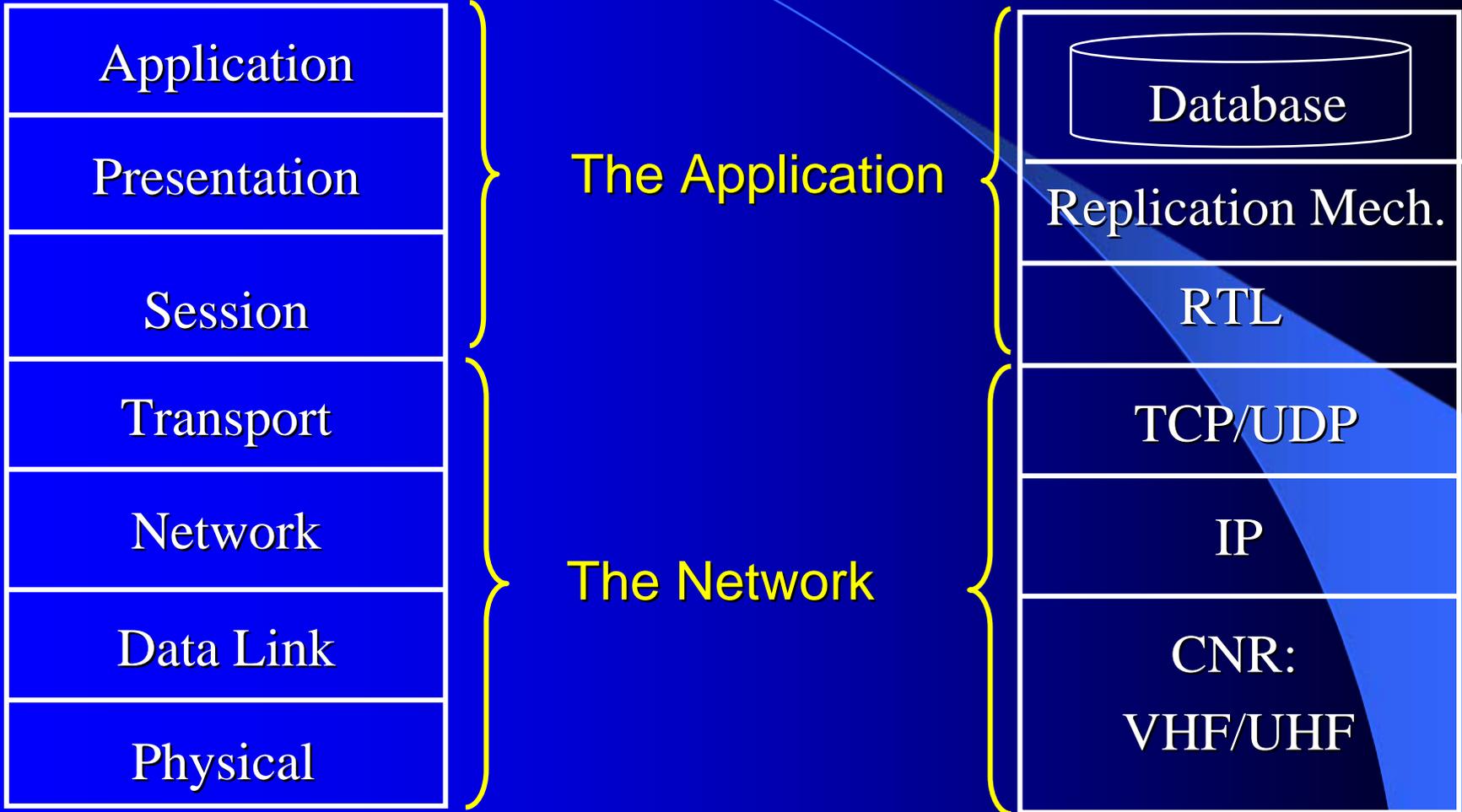
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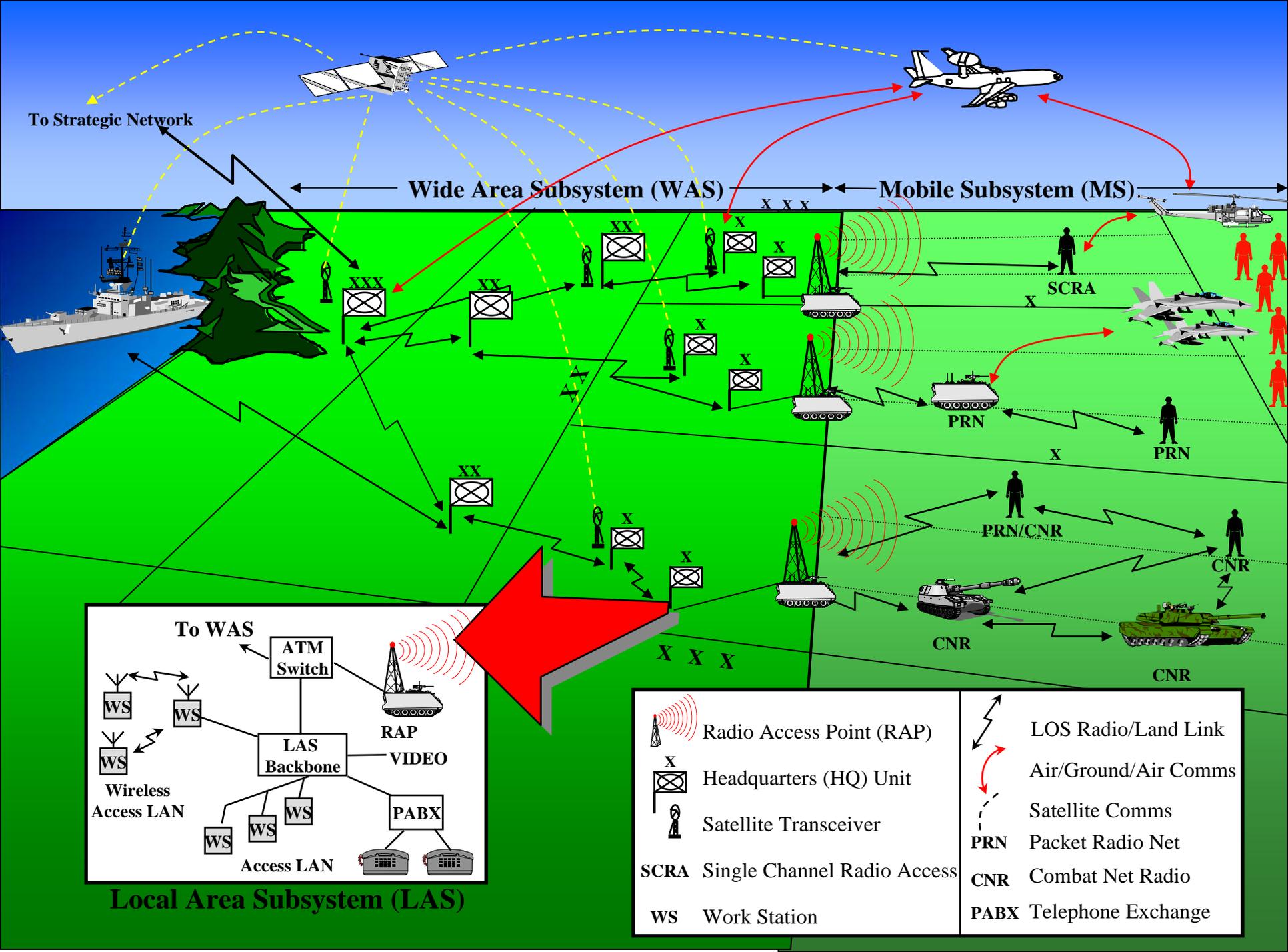
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Outline

- **The Requirement – C4ISR(C2IS).**
- **The CNR Environment.**
- **TCP/IP Performance.**
- **Data Replication & Replication Transport Mechanisms.**
- **RTL Design Considerations.**
- **Low Bandwidth Test Bed – DRDC Valcartier.**
- **Conclusion.**

Terminology





To Strategic Network

Wide Area Subsystem (WAS)

Mobile Subsystem (MS)

SCRA

PRN

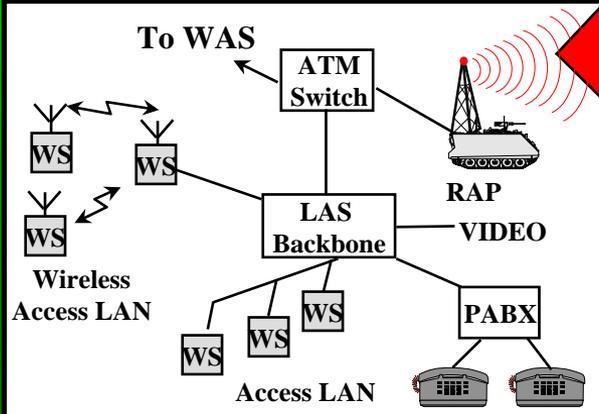
PRN

PRN/CNR

CNR

CNR

CNR



Local Area Subsystem (LAS)

	Radio Access Point (RAP)		LOS Radio/Land Link
	Headquarters (HQ) Unit		Air/Ground/Air Comms
	Satellite Transceiver		Satellite Comms
	Packet Radio Net		Combat Net Radio
	Single Channel Radio Access		Telephone Exchange
	Work Station		

The Requirement

- Migration of C2ISs to FEBA where CNR is primary comms.
- DBMSs with Replication to partially replace/supplement MMHS.
- International programs like ATCCIS/MIP are moving in this direction.

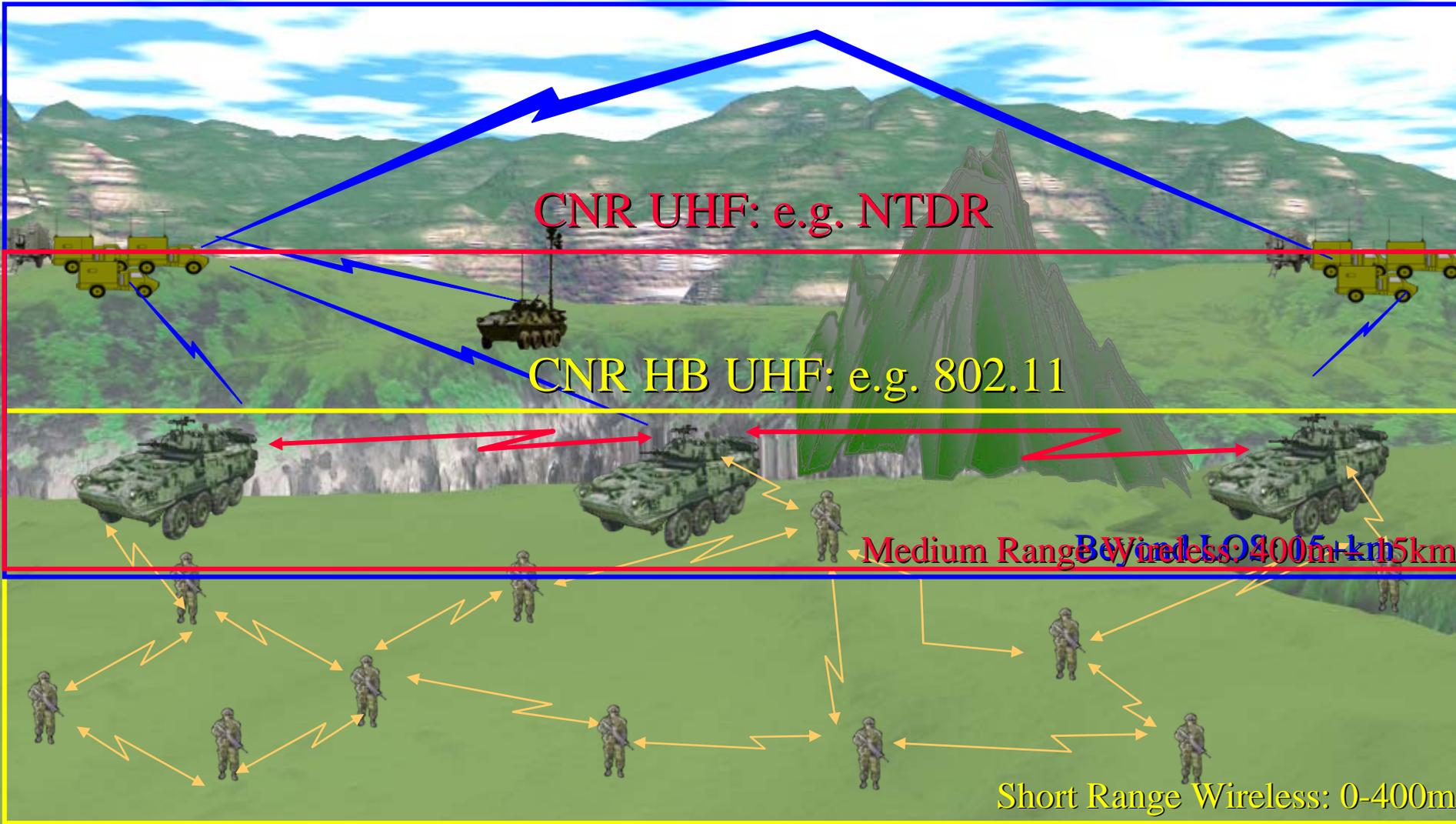
CNR VHF: e.g. CNR(P), SINGARS

CNR UHF: e.g. NTDR

CNR HB UHF: e.g. 802.11

Medium Range Wireless: 400m-15km

Short Range Wireless: 0-400m



CNR Domain

- VHF: Vast Majority of radios capable of 16kbps half duplex.



- UHF: Radios capable of 288kbps full duplex.



- High Band UHF: (e.g. 802.11) capable of 11 Mbps.

CNR – VHF (Cdn Example)

- Reality: usable throughput at the application layer is a fraction of the base rate:

CNR(P) – Max throughput on DATA ONLY network: ~ 1kbps

SHARED AMONGST USERS

→ 25 radios/net = 40 bps/user

- Reality: residual BER as low as 10^{-5}
- Other VHF CNR radios have similar performance

CNR – UHF (225-450Mhz)

- NTDR – 288 kbps is for ‘well situated’ sites
- Reality: truly tactical environment performance is approximately:
 - ◆ ~16kbps from 22kbps link; and
 - ◆ ~80kbps using a 100 kbps link;
- Available throughput is still shared amongst users ($80\text{kbps}/25 = 3.2 \text{ kbps}$).
- Error conditions similar to VHF

CNR – High UHF (2.4 GHz)

- 802.11 – 11,5,2, & 1 Mbps
- Throughput at application layer is ~50% of stated maximum (with AP).
- Throughput significantly effected by:
 - ◆ Speed of units (36km/h = ~50% cut) ; and
 - ◆ Foliage/Antenna position;
- Higher rates not realistic in tactical domain



TCP

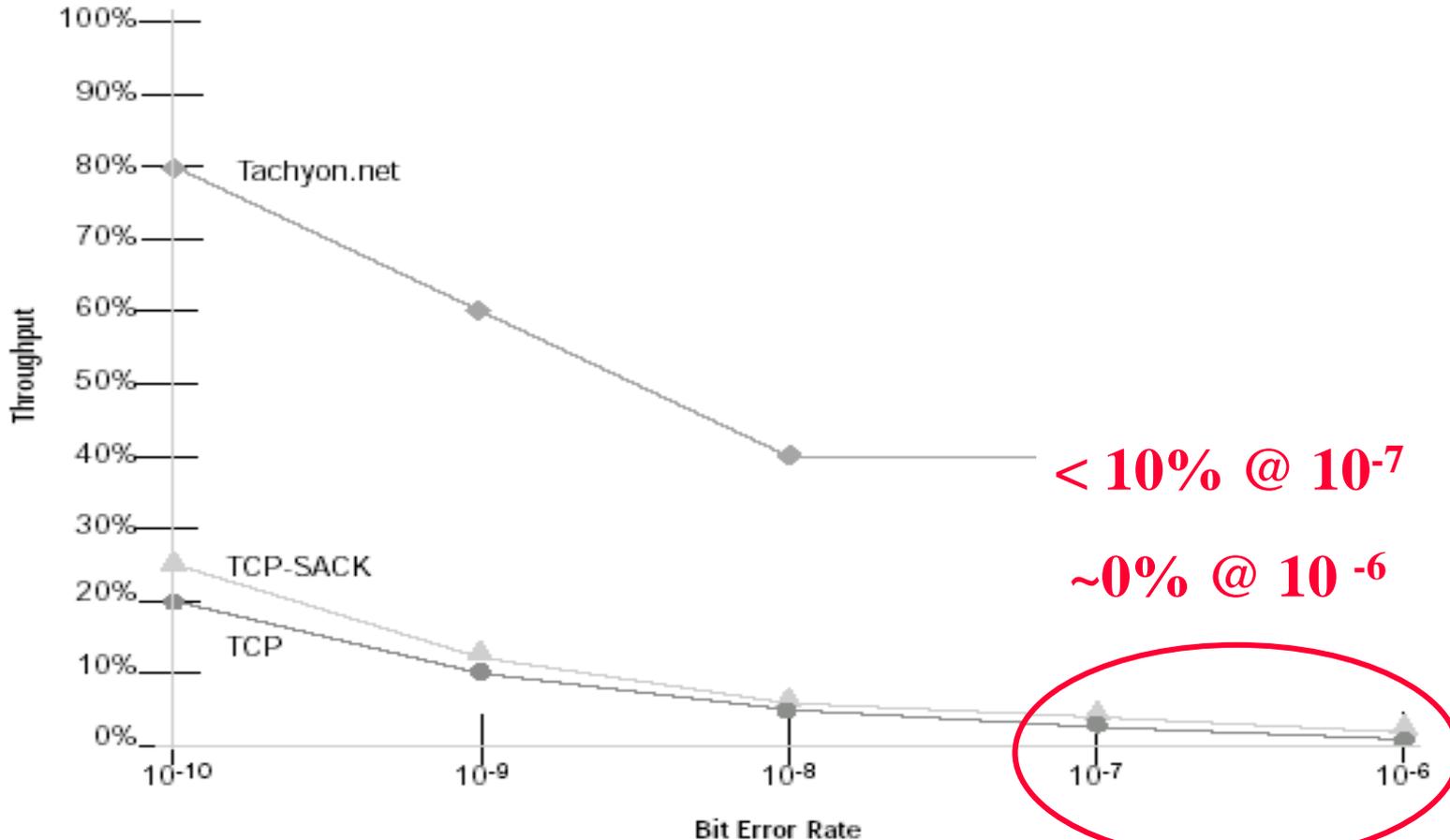
- TCP was designed for wired networks →:
 - ◆ All controls designed for congestion, not errors →
 - ◆ TCP is very sensitive to BER and Latency →
 - ◆ Error in wireless domain trigger TCP congestion controls (e.g. 1 packet lost = 50% cut in tx rate)
 - ◆ TCP is connection-oriented → in wireless tact. domain (high BER, latency, long fades) TCP connections timeout regularly

TCP

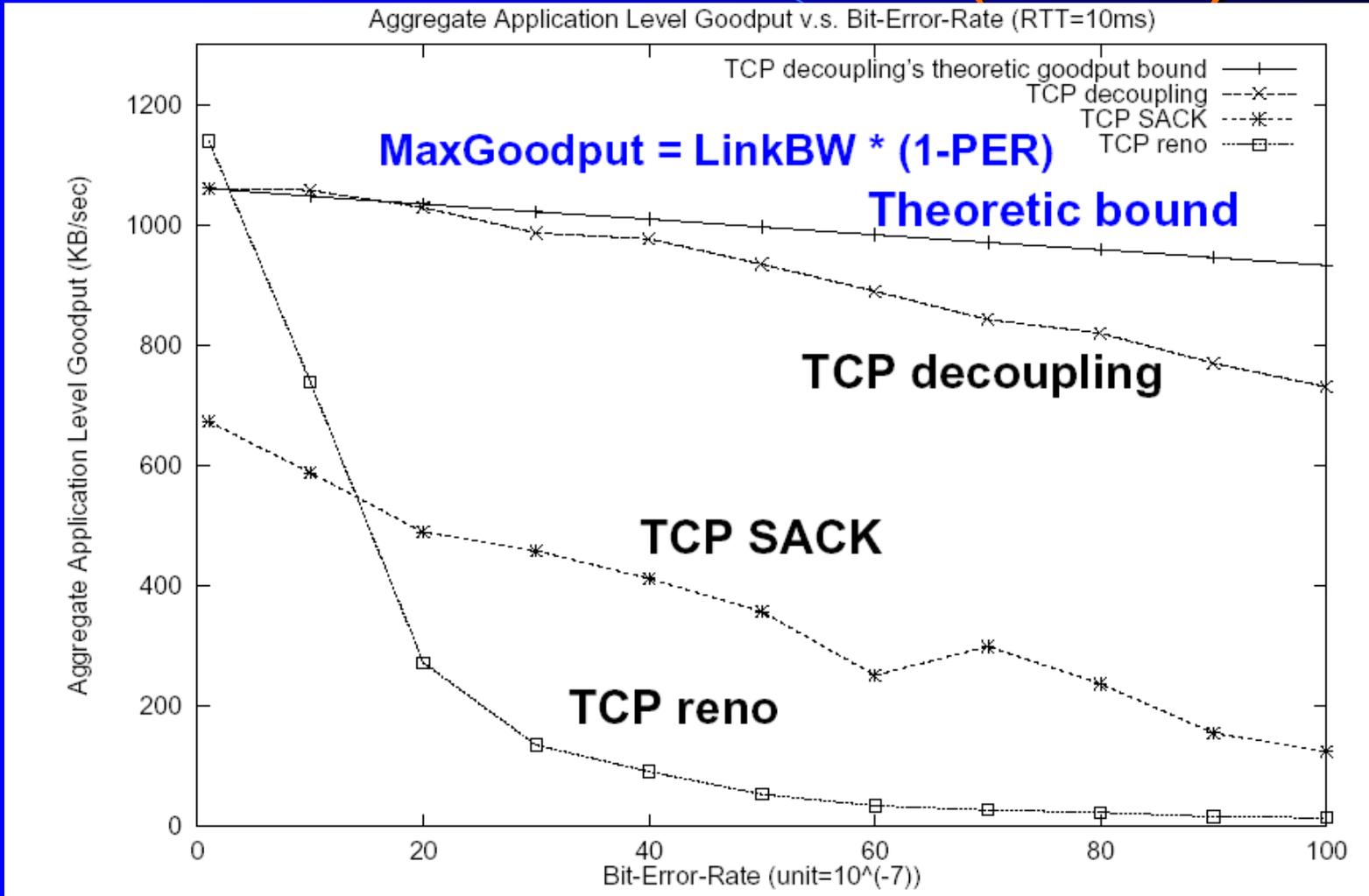
- **THEREFORE:**

Standard TCP is non-functional in most tactical wireless environments!!

TCP and BER



TCP and BER (con't)



Data Replication & the RTL

- Topology: Master/Slave, Peer-to-Peer
- Replication Transport Layer:
 - ◆ Synchronous – i.e. two-phase commit
 - ◆ Asynchronous – Periodic/Aperiodic

All commercial RTLs use TCP!
(No acceptable loss of data!!)

RTL for Tactical Comms.

- RTL must meet the requirements of IM and the capabilities of the network.
- IM Requirements affecting the RTL:
 - ✦ Requirement to distribute data for operational purposes (e.g. position updates, compensate for losses)
- Network Capabilities affecting the RTL:
 - ✦ Shared media (e.g. inherent broadcast)
 - ✦ High Error and Latency; and
 - ✦ Relatively low throughput.
 - ✦ Unreliable links (e.g. prolonged fade)

RTL – Design Criteria

- The RTL should:
 - ✦ Take advantage of the shared media aspects;
 - ✦ Be able to tolerate loss and high delay;
 - ✦ Compensate for radio link loss;
 - ✦ Ensure max. communications efficiency while providing guaranteed level of service for prime data;
 - ✦ Be independent of the DM used;
 - ✦ Use a standard, connectionless transport layer; and
 - ✦ Be able to detect and route certain data to other units who enter the network.

LBTB - Background

IRIS Corrective Options:

- **Increase Network Throughput:**

- ◆ Modify RDL;
- ◆ Data compression;
- ◆ Production of high-rate VHF modem;
- ◆ Purchase new data radio (e.g. NTDR); and
- ◆ Separate voice and data networks.

- **Information Management**

- ◆ ‘The right information, to the right user, at the right time’
- ◆ Data Fusion, Streamlining, Priority Levels, Data Replication, DBMS Triggers and Stored Procedures etc.

Test Bed Objective

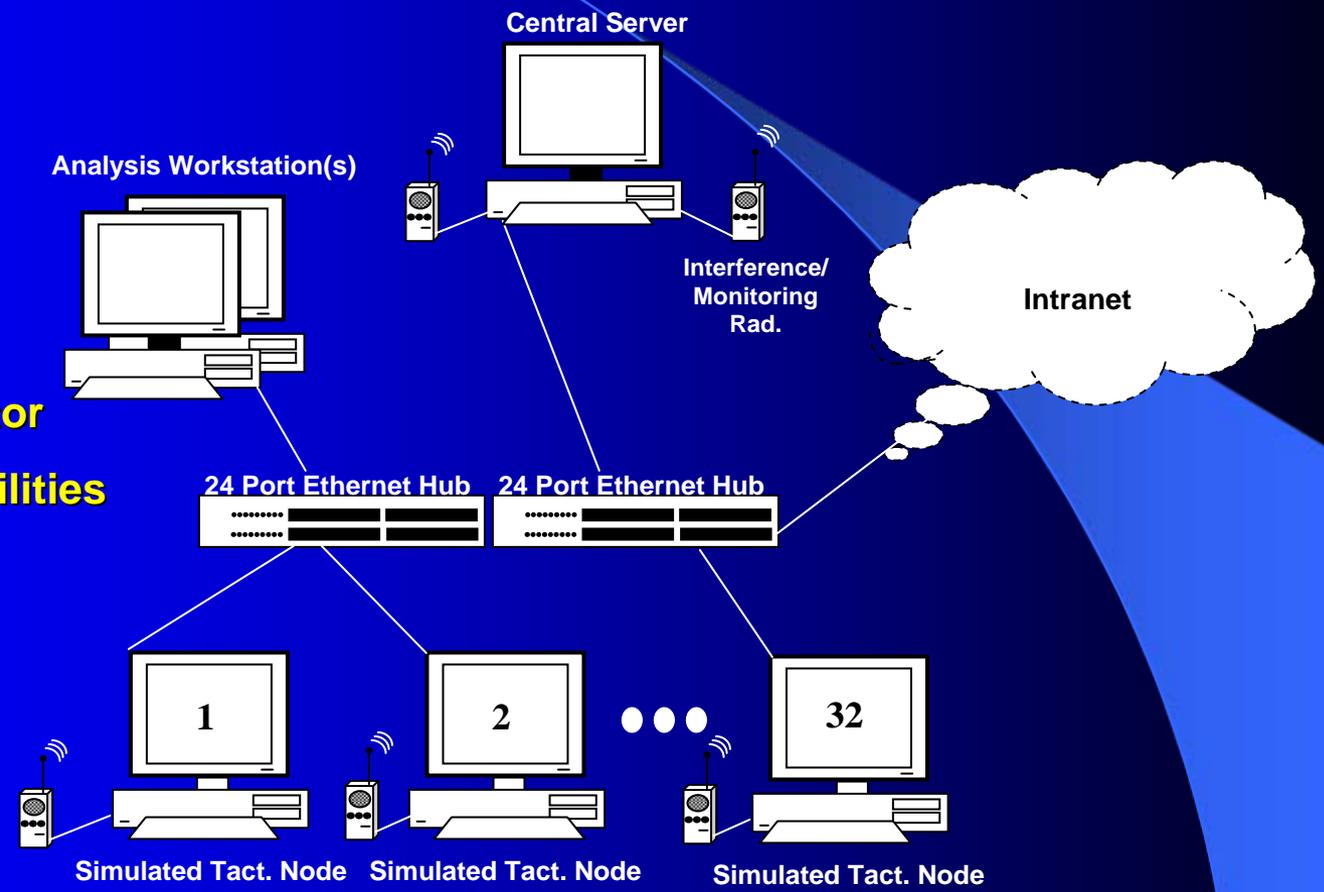
To:

- a. Design;***
- b. Build;***
- c. Test; and***
- d. Install***

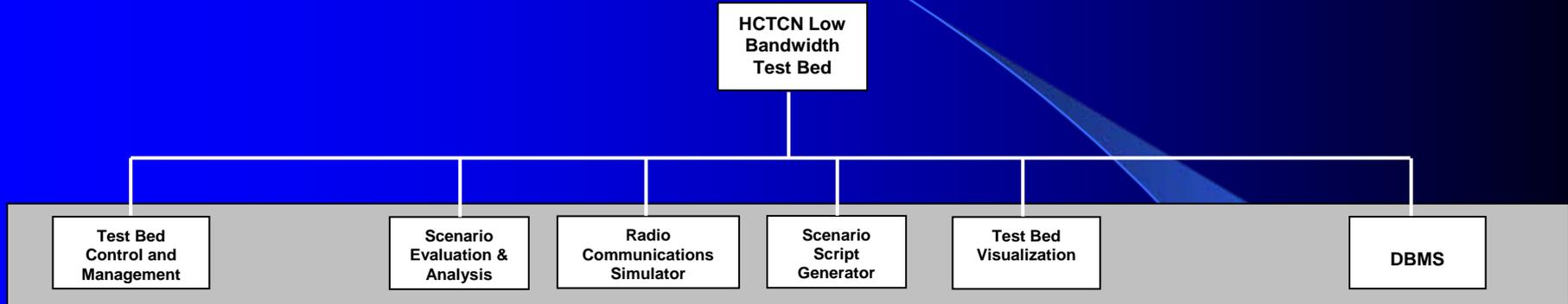
a research test bed to evaluate battlefield IM strategies applied in a low bandwidth tactical wireless communications environment.

System Overview

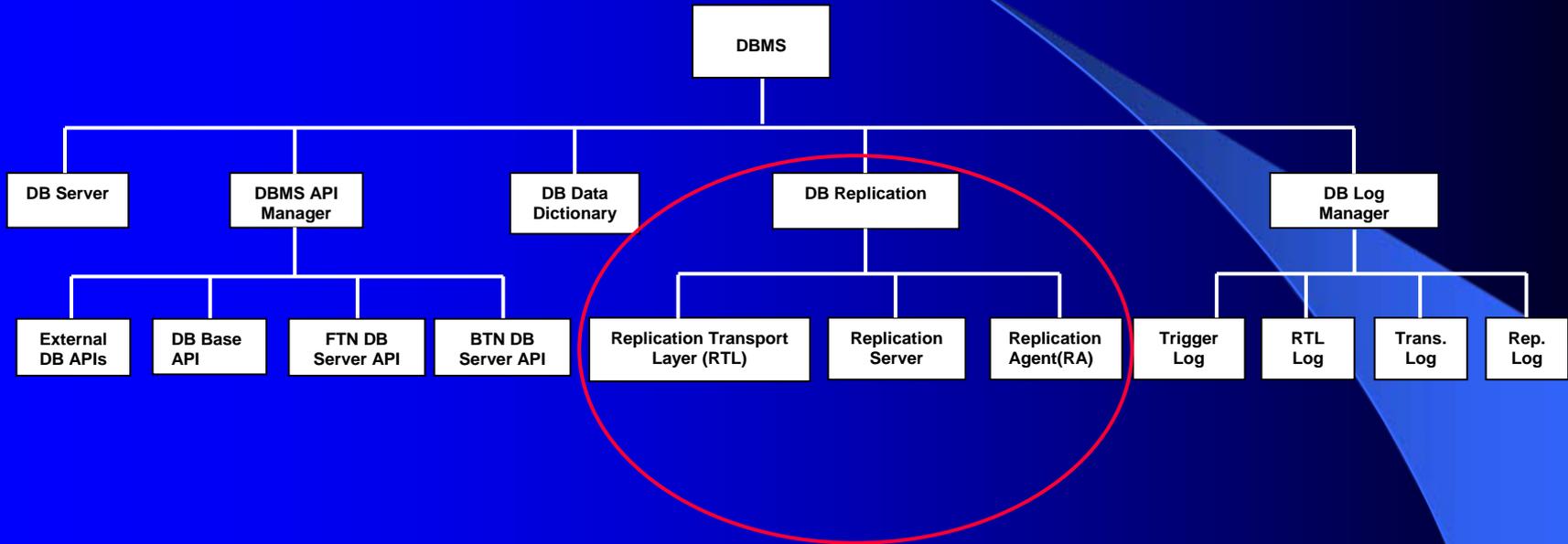
- 1. Traffic Source/Sink
- 2. Comms Sys. Simulator
- 3. Measurement Capabilities



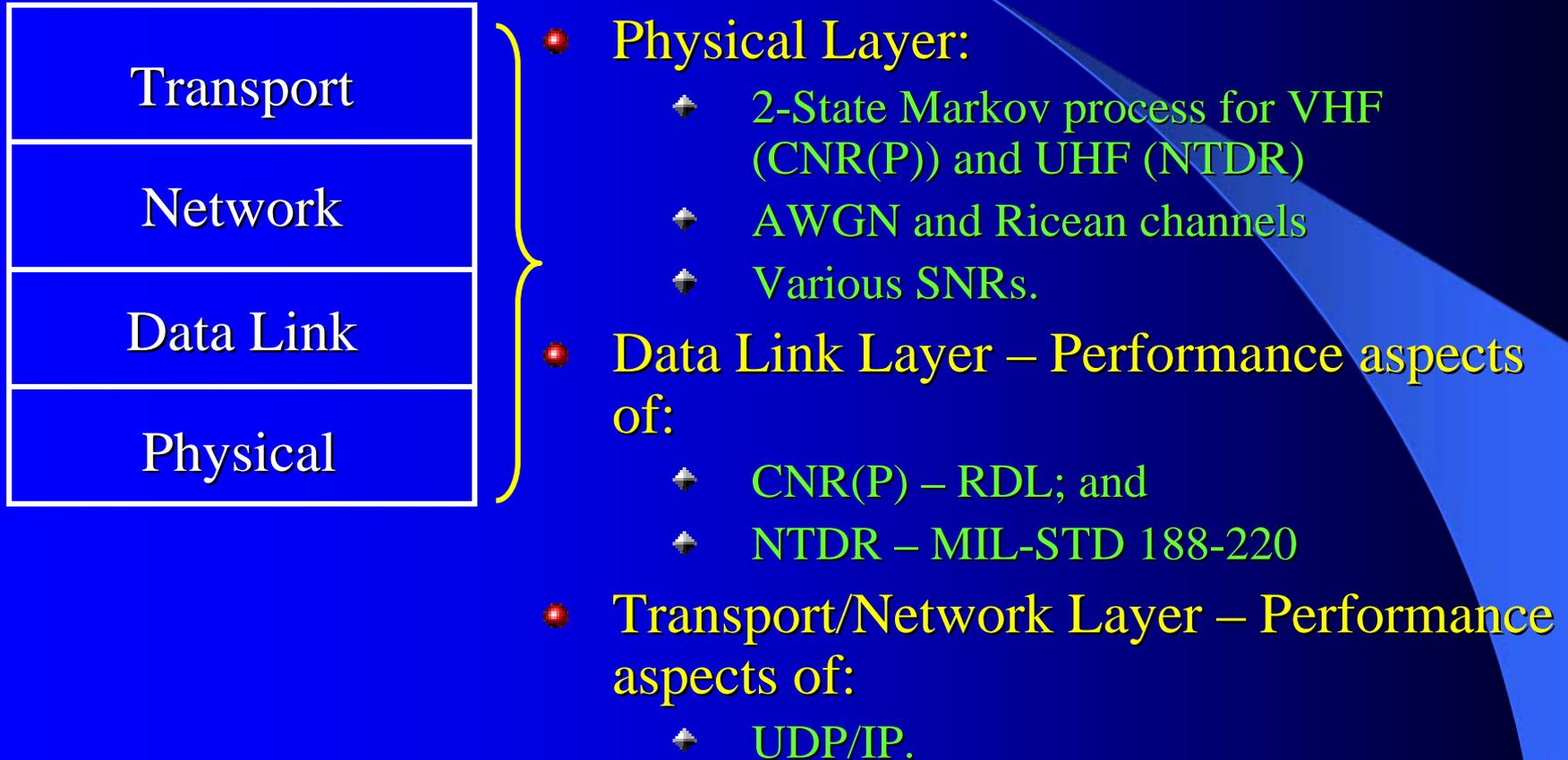
High-Level Functional Architecture



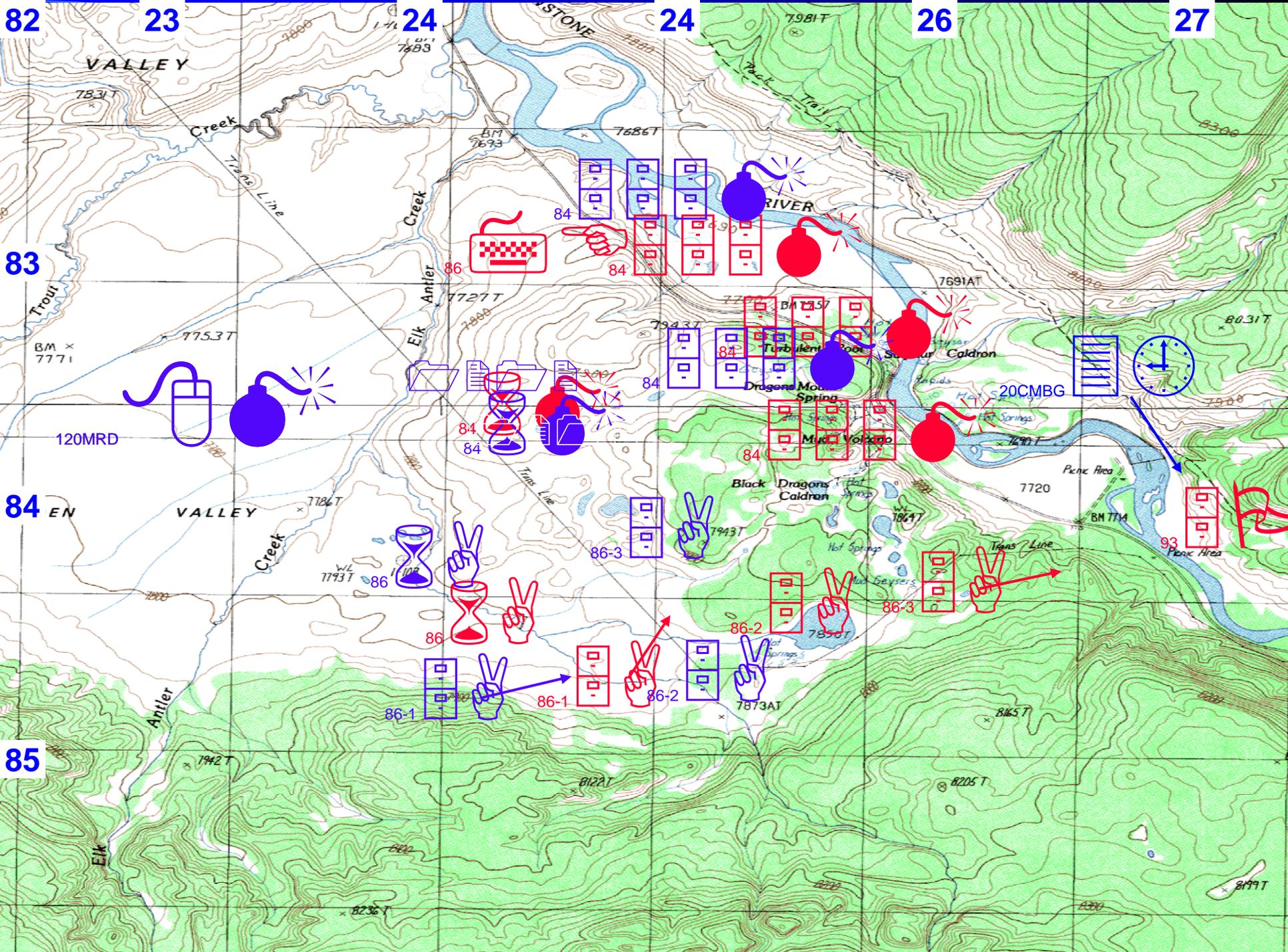
DBMS – DB Replication



Radio Communications Simulator



File Edit View					View
Event	Scenario Time	Node ID	Action/Message/Vector	Parameter	
114	10:35.00	STN01	Enemy Report	Pos:35.09, 115.03; T-72, Qty:3;Ar	D+10:35.00; # 114
115	10:35.15	STN06	Enemy Report	Pos:35.09, 115.06; T-72, Qty:5;Ar	D+10:35.15; # 115
116	10:37.00	STN04	Position Report	Pos:32.02, 114.03; STN04;10:37;	D+10:37.00; # 116
117	10:38.00	BKGND01	Vector Movement 3/32	Pos:31.02, 115; Sp:32km/h;10:38	D+10:38.00; # 117
118	10:38.30	STN06	Fire Mission	Pos:35.09, 115.03; Ord:105mm	D+10:38.30; # 118
119	10:39.00	STN18	Regular Position Report 13/64	Pos:30.09, 112.03; STN18; 10:39;	D+10:39.00; # 119
120	10:39.23	BKGND02	Vector Movement 16/87	Pos:32.02, 113; Sp:16km/h;10:39.	D+10:39.23; # 120
121	10:40.02	STN06	Fire Mission	Pos:35.08, 115.02; Ord:105mm	D+10:40.02; # 121
122	10:40.37	STN01	Enemy Damage Report	Pos:35.08, 115.02; T-72, Qty3;Ar	D+10:40.37; # 122
123	10:41.14	BKGND01	Vector Movement 4/32	Pos:31.03,115.01;Sp:32km/h;10:4	D+10:41.14; # 123
124	10:41.32	STN14	Enemy Report	Pos:35.09, 115.03; Mech Inf;40;	D+10:41.32; # 124
Input Mode: New Event					D+10:42.00; # 125
<div style="display: flex; justify-content: space-between;"> <div> <p>Node: <input type="text" value="STN01"/> <input type="button" value="Add New"/></p> <ul style="list-style-type: none"> STN03 STN04 BKGND01 BKGND02 </div> <div> <p>Time: <input type="text" value="10:42.00"/></p> </div> <div> <p>Action/Message/Vector Type:</p> <ul style="list-style-type: none"> Position Report Enemy Situation Report Vector Movement Regular Position Report Fire Mission </div> </div>					D+10:42.43; # 126
Parameters:					D+10:43.04; # 127
<p>X-Coordinate: <input type="text"/> Y-Coordinate: <input type="text"/> Z-Coordinate: <input type="text"/></p>					D+10:43.17; # 128
					D+10:43.17; # 129
					D+10:43.19; # 130
					D+10:43.22; # 131
					D+10:43.23; # 132
					D+10:43.30; # 133
					D+10:44.01; # 134
					D+10:44.14; # 135
					D+10:44.22; # 136
					D+10:44.29; # 137
					D+10:44.36; # 138
					D+10:47.52; # 139
					D+10:4757; # 140
					D+10:48.12; # 141
					D+10:49.44; # 145
					D+10:49.54; # 146
					D+10:51.29; # 147
					D+10:54.36; # 148
					D+10:54.55; # 149
					D+10:57.57; # 150



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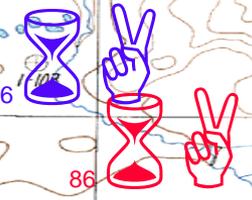
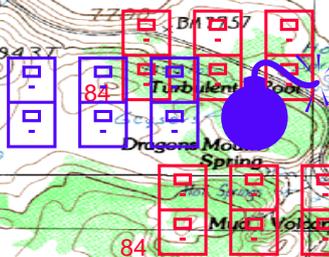
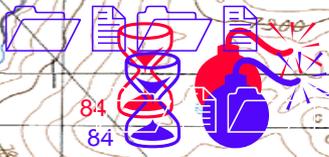
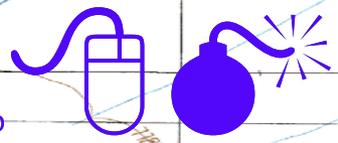
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84 EN

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120MRD

20CMBG



Conclusion

- Data Replication in CNR environment (VHF, UHF) requires redesign of RTL
- RTL must consider:
 - ◆ Operational requirements for data distribution; and
 - ◆ Capabilities/Constraints of VHF/UHF media
- LBTB has design and will implement a unique RTL for this environment.

Question

