

AAN

2016

FORCE XXI

Today's
Army

2006

1996

The Army After Next

**Suggestions from the
Defense Advanced Research Projects Agency**

October 1996

Updated 1 May 1997

Sponsor

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Some Suggestions for Army After Next

A Paper Version of a Hypertext Report

Background. In May 1996 Larry Lynn directed the Office of Tactical Technology (TTO), DARPA, to develop some concepts that might be useful to Commander, TRADOC, as his deputy chief of staff for doctrine moved ahead with the Army After Next Project. John Gully of Land Systems, TTO, took the lead, and convened an informal study group, listed on the outside front cover, that met from time to time throughout the summer. DARPA's PMs were participants, as were a number of experts from industry and academia. When there was a recognizable thesis, it was presented to the red team, and adjusted accordingly. In October the results were briefed to the TRADOC principals, and in November to the TRADOC staff.

Study Guidance. We were tasked (a) to "think out of the box," (b) to present tactical concepts that would exploit foreseeable technologies, and (c) to portray these in a variety of plausible politico-military scenarios. After some debate, we proposed to Larry Lynn that we bypass (3): the tough issues of "plausible scenarios," "peer competitors," "locus of conflict," etc., seemed to us far less important and far less certain than what we could project as strengths of the United States 20 years hence, and what we could reasonably assume would then be this country's continued role in the international order.

Report Format. We adopted the "rolling briefing" procedure familiar to Defense Science Board studies — iterative improvement and augmentation of a set of charts. We calculated, however, that an important part of our message was our medium and method: we undertook to build the charts in hypertext, using the venerable, austere graphic program of that name. Our first step was to lay out the study architecture shown on the chart opposite, which we refer to as the "AAN Map." We defined three broad areas for inquiry and input:

Planning (what is the problem, and how should TRADOC think about it?)

Required Capabilities (what should be expected of land forces 20 years from now?)

Enabling Technologies (what can science and engineering do to meet such expectations?)

Within each of these three areas, we built "stacks" of charts to which all participants contributed. Most transactions to add, modify or subtract from charts were by E-mail. The master set of charts was maintained on a single 3.5 inch disk (<1.4MB), and ultimately was presented to TRADOC via a computer-driven projector, backed by a disk. DARPA, however, insisted upon paper output, of which this notebook is a descendant.

This version records what we turned in October 1996. There have been few changes since 1996 beyond correcting spelling errors, eliminating duplication, and adding hyperlinks.

Salient Concepts. There are two dominant themes:

Go with the commercial flow [e.g., Stacks 3, 15, 16]

Focus AAN on early entry: project a corps-worth of combat power anywhere in the world within 72 hours [Stack 8] by (1) re-engineering means for direct and indirect close-support fires; (2) adopting new classes of lighter and more capable land vehicles and ubiquitous UAVs; (3) devising new information systems [Stacks 6,17, 26,21,25]; and (4) finding fast, high-capacity airlift and sealift so that Force XXI remains strategically relevant [Stacks 15,16, 19, 23].

Planning

2 Assumptions

3 U.S. Strengths

4 Investment Plan

5 Marketing AAN

1 Problem? *

6 Development

7 Evaluation

Required Capabilities

9 Strategic Mobility

10 Overmatch

8 CONCEPT

11 Tactical Agility

12 Logistic Efficiency

30 Conceptual Units

13 Superior Personnel

14 Medical Surety

Enabling Technologies

15 Overseas Shipping

16 CRAF

17 Informatics

18 Telemedicine

19 Containerize

20 Wireless Comm

21 Land Vehicles

22 Energy

23 MOB, LOTS

24 Geolocation

25 UAV

26 Modernized Artillery

27 Infantry AN

28 Training Tech

29 Simulation

- Why does US need Land Forces (Army, USMC)?
- Why not rely on precision weapons delivered by air?
- Can technology make Land Forces more cost-effective?

111

- Every President, as Commander-in-Chief, has ordered land forces into action*
- Recent Presidents have been demonstrably more willing to commit land forces overseas
 - 1950-1989: 10 major deployments
 - 1990-1997: 27 major deployments
 - Today: 35,000 troops in 70 countries

* D.A. The Army Almanac, 1950
Collins, JM. America's Small Wars, 1991

111

The Anxious August of 1990

Drawing the "Line in the Sand"

6 Iraqi heavy divisions with +1000 T-72 MBT within 200 miles of air and seaports of debarkation in Saudi Arabia

S	M	T	W	T	F	S
29	30	31	1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	1
2	3	4	5	6	7	8

- 2 Iraq invades Kuwait
- 6 NCA directs deployment 82d & 24th Div
- 8 Lead airborne brigade commence deployment
- 12 Closure of lead brigade — 3 infantry bns, 1 company M551 Sheridan light tanks, 1 Apache battalion, 1 battalion 105mm howitzers
- 13 Lead mech brigade ships from Savannah
- 17 101st Div lead brigade commences airlift
- 22 First pre-po log ship arrives from Diego Garcia
- 24 12000 soldiers, 3 bde hq, 9 infantry battalions of 82d Div in theater+3 bns 101st
- 27 1st ships of 24th Div arrive in theater

111

Desert Storm

- Army shipped 2.2 million tons dry
- 60% total was ammo, mainly arty
- Army returned 1.6 million tons dry
- Not clear what was fired at enemy
- USAF delivered 70,000 tons of ordnance; 40 tons of fuel per ton delivered

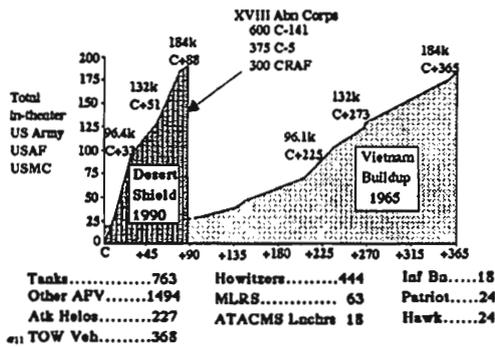
111

Why commit land forces?

- ☑ To deter the use of violence for political purposes
 - Evidence U.S. determination
 - Enhearten allies
- ☑ To control territory and people
 - Forestall or redress aggression
 - Destroy or neutralize hostile forces
 - Separate combatants
 - Conduct humanitarian operations
- ☑ To secure bases for air and sea forces
- ☑ To discriminate in using firepower
- ☑ To win conclusively
 - Delay, disrupt, or deceive hostile forces
 - Enable decisive fires and dominant maneuver

111

Force Generation Saudi Arabia vs. RVN



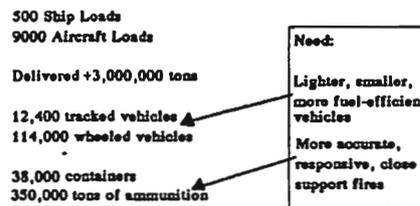
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Lessons Learned from August '90

- Airlift positioned the deterrent force — Aug=airlift
- Fast ports are as important as fast ships. Lead bde of 24th Division took more than one week to load.
- Defense by 82d depended on defiles through salt flats (sabkhas) and TOW-equipped HMMWVs+ Apaches
- Political show of unity by Arab Coalition coupled with show of US resolve gave Saddam Hussein pause
- Host-nation support crucial: Saudis provided ports, airfields, cantonments, water, and fuel : more than 20 million gallons per day!

111

Desert Storm



111

The Current Division

- ~ 17,000 men (~ 2000 tons)
- ~ 5,000 vehicles (~1500 tracked)
- ~ over 100,000 tons combat loaded
- ~ 2,500 tons per day of all classes of supply, spares, and consumables

<p>Tactical mobility high Strategic mobility low Logistically burdensome</p>
--

#11

The Make-weights

- Armored and tracked vehicles (65%)
 - Tanks, IFV
 - Artillery
 - Engineer vehicles
 - Provisions for sustaining same
- Fuel and dry cargo lift fleet (~20%)
- Artillery ammo (~50% resupply)
- Fuel (~25% resupply)

1211

Possible Technology Interventions

- ✓• Develop rapidly deployable artillery
- ✓• Lighten the AFV fleet
- ✓• Reduce manpower in combat theater
- Deliberately align Army with commercial thrusts

✓ *DARPA technology can assist*

1111

AAN Map

Assumptions

re the

Army After Next

AAN is IOC 2016 (20 years hence)

Exploits lessons, legacies, from Force XXI but comparatively affordable and significantly more effective

Structural and doctrinal reforms useful, but must be technologically attainable and reasonably affordable

1/3

- AAN must be important to the NCA in all phases of any crisis

Deterrence	Sustained Operations on Land
Preemption	Setting the conditions
Early Entry	Decisive engagements
Permissive	Transition to peace
Forcible	Return to normalcy

- AAN: ready for the entire spectrum of conflict

Humanitarian Relief	Minor Contingencies
Peacekeeping	Major Regional Contingency
Permissive	Multiple wars
Forcible	Global war

3/3

AAN MAP

Assumptions

- AAN must be capable of coping with a broad range of threats, ranging from:
 - conducting large-scale operations on land to contest a foreign aggressor
 - to
 - providing aid to domestic civil authority
- AAN must be configured to fight overseas under a unified command within a coalition

2/3

Build On U.S. Supremacy in 2016 in Business Related to...

- Information technologies
- Space and exosphere
- Civil aviation
- Transmodal shipment
- Directed energy
- Bio-pharmaco-technology
- Microelectrical
Mechanical Systems

1/8

Commerce will
outpace DoD in
capacity, rate of
change. AAN
must follow that
lead, help shape
outcomes

Information Technologies

- Computing
- Geolocating
- Communicating
- Sensing
- Cryptography
- Multi-source fusion and filtering

2/8

Space and Exosphere

- Commercial global cellular telephony
 - High-capacity terrestrial trunks
 - Ubiquitous broad-band wireless connectivity
- Cheap-launch capability
 - Satellites on demand
 - In-orbit servicing
- Crisis area overwatch
 - Constant-stare
 - Focused-ear

3/8

Civil Aviation

- Passenger
 - Improved commuter service (VTOL?)
 - Wide-body long haul
 - High-speed intercontinental service
- Freight
 - Automated, digitally-managed materiel handling
 - Total asset visibility
- Automated air traffic control

4/8

Transmodal Shipment

- Most trans-oceanic commerce will be container-borne
- Fast (~35kt) container ships are probable
- Iso-containers are congruent with prime needs of land forces:
 - Packaged for strategic mobility
 - Transmodal (truck-rail-air-sea)
 - Inherent shelter from which to work, in which to live (cover and concealment)

5/8

Directed Energy (DE)

- U.S. has lead from SDI
 - DEW by 2002. RF weapons by 2007
 - Particle beam weapons by 2016?
- Deployable DE weapon system (forward air defense) now in development
- DE appears apt for AAN
 - Highly discriminate:
 - Precision aim
 - Tuned power
 - Useful in MOBA
 - Logistically superior to missiles

6/8

BIO-PHARMACO-TECHNOLOGY

- Pharmacologic syntheses
- Bio-fabrication
 - Designer microbes for organic processing and conversions
 - Synthetic DNA for novel structures e.g., optical data storage
- Bio-mimetics
 - Systems that emulate living organisms or organic materials
- New armor, comms, power sources

7/8

Micro-electric Mechanical Systems (MEMS)

- Silicon-based, chip-level manufacturing
- Throw-away entities
- Enables:
 - Networks of very small, taskable machines
 - Very small turbo-generators, jet engines
 - Self-instrumented structures
 - Hyper-portable navigational systems
 - Cooperative RSTA/C³I

8/8

AAN MAP

Stack: Investment Strategy

- Over the past two decades, the Army has bought impressive new capabilities for mounted warfare, powerful, mobile combat support, and extensive combat service support.

Light forces have not been comparably improved. MOUT readiness is low.

- Cultural imperatives and inertia have created strong propensities for more of same.

1/10

DoD TOA is likely to stagnate or decline

- * USAF, USN systems will dominate
- Three broad alternatives
 - (1) Win over OSD/Congress to Army logic
 - (2) Subvene OSD with Congress/Transitioners
 - (3) Army vision ~ OSD/Congress' priorities
- (1) is on the record unproductive
- (2) is dubious ethics, shortsighted
- (3) works: USAF, USN, USMC formula

3/10

AAN Investment Strategies

- Demonstrate that the Army is serious
 - "Open mind," "thinking out of the box"
 - Work future back vs. present forward
 - Bold vs. creeping adjustment
 - Seek new allies, especially in business
 - Use simulation to create AAN converts
- Buy "leaner" and "meaner" and "fewer" as opposed to "bigger and more"

5/10

AAN Investment Strategies

- Leverage investments by other services
 - * USAF, USN lead in missile technologies for space, air-to-air, air-to-ground
 - * Army missiles should spin-off ground-to-ground, ground-to-air versions
- Communications must clone commercial
 - * Legacy SINCGARS, MSE won't cut it
 - * Business (and AAN) needs bandwidth
 - * AAN should shape encryption, weight, power, field interfaces

7/10

Army Modernization is Gravely Underfunded

- Total Army FY 97 TOA is 25% of DoD's \$244B
- Army RDA TOA is 14.4% of DoD's \$73.3B
 - USAF 39.3%; USN 30.9%; DoD 15.4%
 - Army RDA is down 66% from 1985
- Of DoD top 20 modernization programs:
 - Army has only 3 (artillery piece, helo, tank)
 - Army programs amount to only 7.2% of total
 - USMC 8%; USN 37.5%; USAF 36.2%
 - OSD 10.3%
- Army's arty piece is 60 tons; tank is 71 tons

2/10

OSD, Congress have been buying:

Support for CINCs

- OOTW/LIC
- Counters to WMD
- Systems for the Information War
- Focus of the "onset of war"

Pilot Projects

- Acquisition reform
- Industry participation
- Joint and combined forces

ACTD

4/10

AAN Investment Strategies

- Accept a differentiated force
 - * Heavy and light units
 - * Modernized and older unit sets
- Priority for early entry forces
- Seek economies and efficiencies:
 - * Smaller, fewer headquarters
 - * Lean combat support
 - * Drastically reduced in-theater CSS

6/10

AAN Investment Strategies

- AAN should seek to influence subsidized industries
 - * Civil Reserve Air Fleet (CRAF)
 - * Merchant Marine
 - * Intermodal transportation means
- AAN should attempt to adapt for its purposes the results from growing R&D (governmental and private) in health care and public safety

8/10

AAN Investment Strategies

- AAN should seek new acquisition paths, such as projects intermixing Army RDA funds with industrial IR&D, and inviting industrial participation in the setting of the requirements for new systems
- AAN should facilitate involving the CINCs of the U&S commands in its modernization decisions

9/10

AAN Investment Strategies

- To dominate onset of any prospective war
 - Avoid arguments re corps Vs. corps
 - Move to "fastest with the mostest"
 - Emphasize Army's proven abilities with allies
- To counter asymmetric threats
 - Limit vulnerability by constraining presence
 - Minimize materiel positioning in-theater
 - Echelon-back: extra-theater or off-shore
- To align with commercial main thrusts

10/10

AAN MAP

New Marketing is Urgently Needed!

Force XXI is seen as "modernizing for yesterday"

- USAF fighters, sensors, munitions
- USN arsenal ships
- USMC Sea Dragon

modernize
for
tomorrow

"Digitization" = appliqué on NATO GDP

"Overwhelming" = massive personnel, materiel

Army procures huge numbers at low cost per unit

1/3

Marketing AAN

- Propose modernization consistent with foregoing. E.g.:
 - Aim at a 10 ton AFV vice 40 tons
 - Stress deployability, versatility
 - Minimize CSS, CS elements
- Conduct exercises to show that AAN:
 - Can get to any conflict and win
 - Can do so with minimal casualties

3/3

AAN MAP

Marketing AAN

- Convince the Congress and the American people that AAN is necessary and affordable
 - Can overmatch any foe from peers to terrorists
 - Evolves from Today's Army and Force XXI
 - Steward of traditions, esprit, ethos
- Emphasize (1) early arrival, and (2) boosted situational understanding to:
 - Deter, paralyze, deceive vice destroy foe
 - Destroy by precise fires vice close combat
 - Protect force by (a) precision CSS; (b) dispersion; and (c) high P_h, P_k

2/3

Distributed Combat Developments

- Collaborate among the Army's branches to design new concepts and materiel collaboratively via:
 - Leading Edge Services (DARPA/DISA comm)
 - NOTES-like interactivity, shared data base
 - Merge C4I with DIS; adopt HLA for C²
 - Internet video, voice, data connections
- Exploit service-to-service links and joint/OSD agencies
 - Evaluate early and often
 - Stimulate first to establish requirements with war-fighters

1/6

AAN Should Seek New Acquisition Paths

Suggestion:

DARPA propose to USD(A), with TRADOC concurrence, a cooperative development project for exploration of the concepts for rapidly deployable modernized artillery — what DARPA refers to as "advanced fire support system."

- (1) A DARPA-industry-TRADOC analysis of alternatives
- (2) A TRADOC sponsored STOW simulation of feasible system(s)
- (3) A JCS-sponsored ATD with prototypes within 5 years

3/6

as of 11/12/96

Four DARPA Initiatives

(✓ = LL OR)

1. Lead industry in an assessment of commercial contributions to military mobility:
 - Intercontinental projection of land power
 - Lighter, more sustainable overland vehicles✓
2. Demonstrate low-cost indirect fire rockets (boost-glide)✓
3. Execute the SUO program
 - Comms/geolocation for restrictive environments✓
 - Technology for teamwork: UAV/wide-aperture sensors/recoilless, precision individual weapons/ combatants = sensor platforms✓/✓/✓
4. Define simulative methodology and technology needed to delineate joint requirements and prototypes for 2016+ ✓

5/6

Distributed Combat Developments

- Form new alliances
 - With the CINCs & components
 - With other services
 - With DARPA
 - With industry
 - Within TRADOC, e.g., with training developers
- Turn technology into AAN capabilities

2/6

AAN Should Seek New Acquisition Paths

Suggestion:

DARPA propose to USD(A), with TRADOC concurrence, a cooperative development project for exploration of concepts for hybrid electric/fossil fuel vehicles:

- (1) A DARPA-industry-TRADOC analysis of alternatives
- (2) A TRADOC sponsored STOW simulation of feasible system(s)
- (3) A JCS-sponsored ATD with prototypes within 5 years

4/6

A Proposed Outline for Analysis

- (1) Is the system technically feasible? What are the risks of the development? What per unit costs seem attainable? What technology will drive cost? effectiveness?
- (2) In measuring cost and effectiveness, what measures of merit will be pertinent? To what analyses will the system have to respond?
- (3) What CONOPS or doctrine is pertinent? Who is the proponent?
- (4) What are the life-cycle logistic implications of the system?
- (5) What are the human factors implications —including institutional and unit training?
- (6) What forms of simulation should be mastered for development? For testing the system? For training and readiness?

6/6

AAN MAP

Therefore...

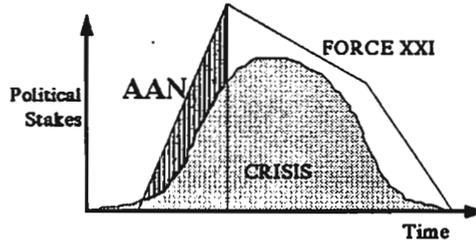
- DARPA Study's findings and recommendations will ultimately be evaluated against politico-military scenarios with these measures of effectiveness:
 - **more affordable than Force XXI**
 - **significantly more capable**
 - **developmental risk acceptable**
- Further, evaluation will weigh extent to which AAN meshes with the capabilities of the other services

The Army After Next will be ready:

- ♦ To project a force more powerful than a present-day corps as the land component of a joint task force
- ♦ Within hours of NCA decision
- ♦ Anywhere in the world
- ♦ Able to fight on arrival and to sustain Dominant maneuver
- Decisive combat support
- Efficient combat service support

1/2

**AAN Intervenes:
Decisively, Early, Jointly**



2/2

Conditions of Future Crises

- People will figure prominently
 - Urban warfare most probable
 - Crowded countrysides also likely
 - Media omnipresent
- Opposing force can buy lethal weapons
 - Chemical, biological, even nuclear
 - Accurate, powerful, long-range missiles
- Enemy can fight as a guerrilla, or terrorist

3/2

Why commit land forces?

- ☒ To deter the use of violence for political purposes
 - Evidence U.S. determination
 - Enhearten allies
- ☒ To control territory and people
 - Forestall or redress aggression
 - Destroy or neutralize hostile forces
 - Separate combatants
 - Conduct humanitarian operations
- ☒ To secure bases for air and sea forces
- ☒ To discriminate in using firepower
- ☒ To terminate conflict
 - Delay, disrupt, or deceive hostile forces
 - Enable decisive fires and dominant maneuver

4/2

"Fustest with the Mostest"

The Advantage of Early Intervention

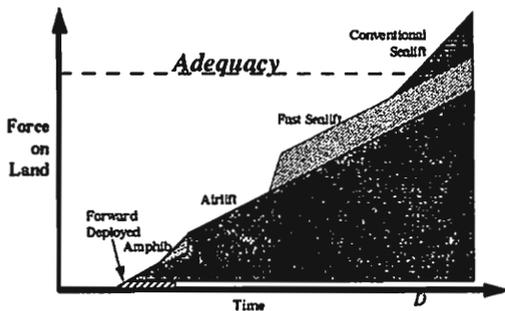
- The ability to intervene early and decisively is the essence of deterrence
- To suppress a crisis early saves blood and treasure
- Military capability broadens diplomacy
- Few crises eventuate in war, but all breed conflict

5/2

Heavy Force Deploys Slowly

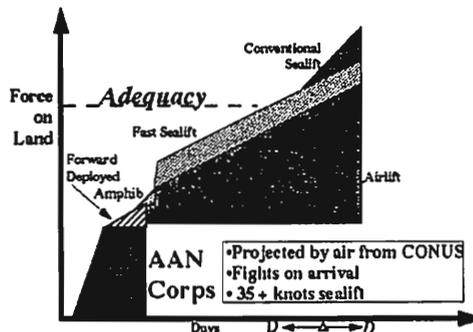
- Division large and ship/port dependent
 - 100,00 tons (of which men alone ~2000 tons)
 - Many movers: 15,000+ soldiers, 5000 veh, 1500 tracks
 - ~65% weight in AFV, Arty, Engr tracks
 - ~20% weight in lift for fuel, dry cargo
- Logistic tail no less onerous
 - 2,500 tons per day all classes of supply
 - ~50% resupply: artillery ammo
 - ~25% resupply: fuel
- AAN must derive combat power with:
 - Less weight and cube
 - More efficient soldiers, vehicles, and fires

6/2



Current Build-up for Counter-offensive

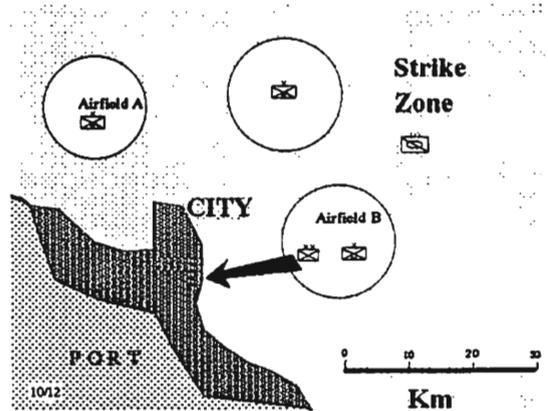
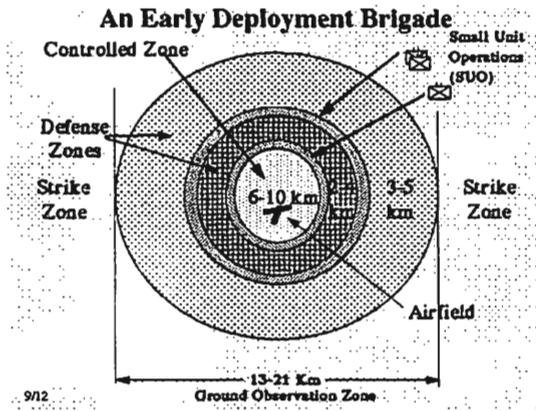
7/2



AAN Build-up for Counter-offensive

8/2

Stack: Concept



One Vision: in 20 Years...

- **Combat forces 33% of current manning**
"Depopulate the zone of vulnerability..."
 - **Firepower 100% that of present force**
"Situational understanding, precision fires..."
 - **Teeth-to-tail ratio (In-theater) > 1.0**
"Less vulnerability to asymmetric counters..."
 - **Logistics just-in-time vice just-in-case**
"Total asset visibility, precision delivery..."
 - **Maintenance by need vice schedule**
"Detect, remove, replace, as coached..."
 - **Acquisition fueled by engine of commerce**
"Market driven, like business..."
- 11/12

The Army After Next

will have to be...

- Strategically mobile**
 - Tactically Agile**
 - Overmatching**
 - Logistically Efficient**
 - Medically Assured**
 - Superlatively Manned**
- 12/12

AAN Map

Strategically Mobile

- Able very rapidly to insert **effective early-entry forces** directly into a hostile environment, to stabilize the situation, find and fix enemy forces, and establish control of territory and population.
- **Minimum footprint** in the objective area.
- Maximum utilization of **commercial means** for both deployment and sustainment.

1/4

RATIONALE

- AAN cannot expect other services to design and invest in mobility platforms to project AAN
 - Scarce military airlift, priority to own needs
 - Constrained "Amphibious" sealift
- Instead, AAN must be configured to exploit fast commercial lift, prepositioning, and sea-basing
 - CRAF: PAX and freight
 - Containerize essentials
 - Mobile Offshore Bases (MOB)
 - Logistics Over the Shore (LOTS)
- Hence, split-based operations will be normal

3/4

"Fustest with the Mostest"
one division within one day of decision
one corps within three days

- Significantly fewer personnel on the ground
 - Echelon back C4I, CSS
 - Extensive reliance on sensors, data distribution
- Lighter, more supportable vehicles
- Modernized artillery for close support
- Reliance on USAF and USN for air superiority
- Broad recourse to commercial airlift via Civil Reserve Aviation Fleet (CRAF)
- Pervasive containerization
 - Commercial shipping
 - Operate either from the sea or ashore
- Mobile Offshore Bases (MOB)

2/4

A Distinctive *Modus Operandi*:

- **Combat Support (CS) and Combat Service Support (CSS) mainly from outside theater using Intercontinental civil air & fast ships, MOB, and LOTS**
- **CS entails modernized artillery**
- **CSS entails extensive "containerization" total asset visibility (TAV), and vigorous interaction with intermodal shippers.**

4/4

AAN Map

Overmatching

- Being **overpowering** in battles and engagements
- Always **having the initiative** in the campaign
- **Remaining in control**
- Successfully **protecting the force**
- **Leveraging joint capabilities**

Operationally Adroit

- **Must dominate variable battle space**
 - + Speed —act faster than enemy can counter —all systems —all levels—fires, maneuver, info-strikes
 - + Space — variety of terrain, geography, enemy forces —CONUS to FLOT and beyond
 - + Timing —unprecedented simultaneity
- **Battle Command less encumbered to enhance flexibility**

Overwhelmingly effective, *able to...*

- Exploit enemy weakness and counter strengths
- **Act on superiority of joint forces and fires**
 - Allow enemy no sanctuaries
 - Discriminate, crippling targeting
- **Dominate in information warfare**
- **Limit own vulnerabilities**
 - Defenses against WMD, TBM, CM
 - Logistic tail outside combat zone
 - Strong air defense for deployed forces
- **Employ denial and deception, control tempo**

Technology for Teamwork

- Teams are what count, not individuals
- Integral with teams must be technology:
 - for mobility
 - for situational understanding
 - for sustainability
- All combatants operate in or with air or ground vehicles
- All entities are under constant control
- All entities are sensor platforms

1/7

Our aggregate tactical weakness stems largely from this... We have encouraged the man to think creatively as a person without stimulating him to act and speak at all times as a member of a team. The emphasis should be kept eternally on the main point: his first duty is to join his force to others!

[Team] unity comes to full cooperation between each man and his neighbor. There is no battle strength within the company or regiment except as it derives from this basic element within the smallest component...

S.L.A. Marshall, *Men Against Fire*, 1947

3/7

Tactical C⁴I

- Low power, cellular, spread spectrum: thousands of subscribers with short-burst data, plus a subset with service for imagery and data streams as well
- Redundant nets, versatile wave forms adaptable to circumstance; multi-mode radios
- Portable base stations for cells in combat zone, capable of geo-positioning transmitters, and interacting with GPS and INS for assured 3D locus
- Interfaces with legacy and long-haul comms
- Network reconfigurable at will to reflect changing tactical relationships

5/7

Technology for Teamwork

- A 3D terrain data base that can be current and responsive to each combatant. N.B. definition requirements vary by orders of magnitude:

Height	Operations/Speed	LOS Range	Altitude Postage
High/Fast		50 km	30 meters
Low/Modular		5 km	12 meters
Afoot		0.5 km	1 meter

- Exploit forward-deployed personnel and vehicles as sensor platforms, for acoustic arrays, distributed MTI
- Position redundantly: GPS, INS, LORAN, cellular
- Track physiological readiness of each combatant, automatic reporting of homeostasis
- Embed AAN TES within C⁴I

7/7

Inf BN

REN Map

Why Structure Around Teams?

- Individuals or pairs unlikely to:
 - Provide for close-in situational awareness
 - Cope with medical emergencies
 - Operate continuously
- IF tactically agile, unit/team size:
 - Seven (~) for 360° security, fire and movement
 - Fourteen (~) for relentless day/night operations
 - Optimize for targeting, controlling fires
- Reduced tactical presence levers CSS

2/7

Relentless Combat

- AAN will have technology to fight 24 hours per day, day in and day out
- Persistent, high tempo operations offer clear advantages over potential foes, particularly when coupled with information warfare
- Out-manuever the foe in mind, in time, in space
- But three preconditions must obtain:
 - Sufficient teams/crews to assure proper sleep
 - Situational understanding for guaranteed effect on enemy
 - CSS sufficient to sustain the pace

4/7

Tactically Agile, able to...

- Engage relentlessly, day or night
- Move at will in three dimensions
- Multiply the situational understanding and firepower of small teams to:
 - Assure cohesion and interoperation
 - Deter, paralyze and deceive the enemy
 - Destroy enemy with discriminate fires
- Reconfigure C⁴I at will
 - Form a network of networks
 - Broad band connectivity to every combatant
 - Interact with aviation and AFV

6/7

Logistically Efficient, *able to...*

- Manage via full and continuous asset visibility
- Resupply on demand
 - Air delivery precise to time and place
 - Robotic vehicles
 - Minimal stockage, personnel in combat zone
- Maintain on need, *vice* schedule
 - Continuous monitoring by MEMS
 - Mentored remove/replace forward
 - Seaborne, containerized CSS units

AAN Map

Changing the In-Theater Teeth-to-Tail Ratio

- Reduce In-Theater CSS to the minimum
- Move from "just-in-case" to "just-in-time"
- Leverage industry
 - Regional procurement
 - Transmodal transportation
 - Informatics
- Echelon back — take no one into theater who can, using moden communications, function from outside
- Maintain on-line logistics data, distributed to all commanders with need-to-know

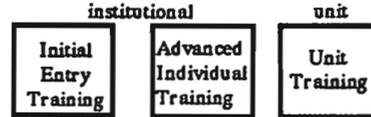
Personnel Policy Implications

- AAN will be in a state of constant readiness, hence:
 - Conscription offers no support for AAN
 - Reserves can figure in AAN, but only in roles for which they can maintain requisite readiness
- AAN combat team manning must be highly selective
- Present approaches to recruiting and training must be modified to accommodate:
 - The requirements high proficiency within each small team
 - The new-old mix of equipment within the Army overall

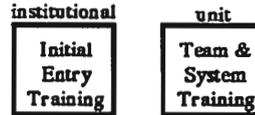
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Training

- Reconfigure current distinctions:

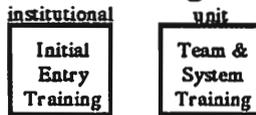


- AAN training should look like this:



25

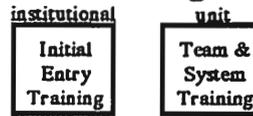
Training



- Requirements for TRADOC in support of AAN:
 - Training developments ahead of AAN fielding for both individual and collective training
 - Embedded training within on-coming AAN materiel
 - Training enablers (job aids, devices, simulators, simulations- constructive, virtual, live)
 - Effective, pervasive distance learning mechanisms and technique

35

Training



- Army After Next will train on the equipment in each unit
- AAN will have broad recourse to TES of all three types
- AAN will train by team, with commanders and team leaders mentoring
- AAN will train within the context of each unit's METL tasks

45

AAN: Rigorously Trained, *able to...*

- Conduct STOW-like training anywhere for all units
 - Generate quickly required terrain data
 - Develop collective skills, rehearse operations
- Use C4I system to capture data for AAR, feedback to combat developments process
- Support most individual training in units (as opposed to schools or training centers)
 - Use organic communications and/or embedded training
 - Employ satellite TV and Internet
- Access TRADOC schools continuously via DISA

55

AAN Map

S faek 14

Medically Assured, *able to...*

- Monitor continuously physiologic readiness of each combatant in zones of high hazard
 - Automatic alarm, locus/first aid/evac
 - First line of defense against BW attacks
 - Deploy supplemental sensors of NBC weapons
- Use telemedicine far-forward
 - Mentor unskilled first aid/ stabilization
 - Remotely-controlled bio-drug infusion
 - Iso-container-housed field hospitals
 - Swift, sure evacuation from theater

Personnel Status Monitor (PSM)

- DARPA/AMEDD development to date
- Vital signs sensors+GPS+computer+radio
- Currently <5 pounds, in LBE harness, optimized to warn of the onset of hypothermia
- Tested by Rangers in July 96, found useful for command and control: tracked Rangers even when swimming river, showed NCOs location each man
- Conforms to DSB vision: a cellular, spread spectrum, LPI/LPD communication system on every soldier
- Insurance against MIA, and against wasting medics trying to reach corpses

Practice in Combat Casualty Care

- PSM enables distributed interactive simulation (DIS)
- Underwrites medical subsystems for all forms of simulation —live, virtual, constructive
- Numbers of patients, type injuries flow from simulation
- Virtual patients realistically train medics, doctors
- Contribute to development of military telemedicine
- Telemedical data streams - intelligence data streams

Telemedicine

AAN Map

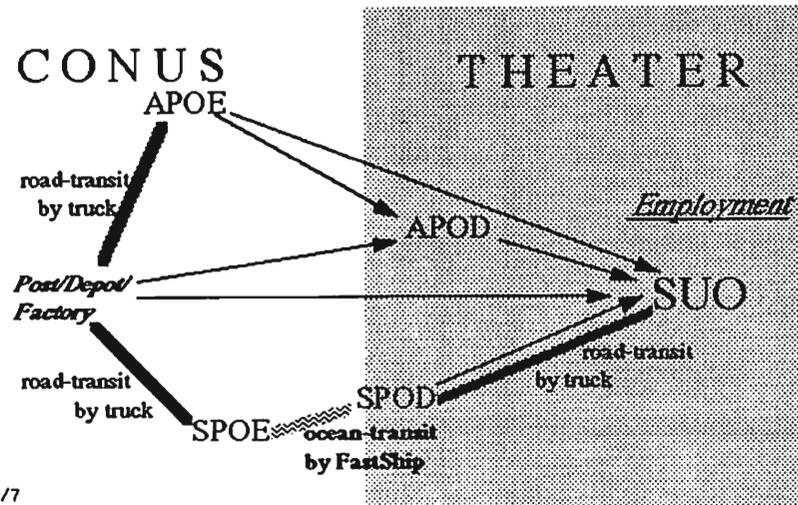
Commercial Overseas Shipping Trends

- Time-sensitive, high-value cargo provides impetus
- Newer container ships will double in size
- New containers of composites for strength, lightness
 - For air (EM transparent for TAV, inspection)
 - For sea (protect items from maker to seller)
- Broader use of RO/RO in high-payoff trade
 - Self-propelled vehicles
 - Air-cushioned pallets for containers
- Hyper-speed ships operating between dedicated ports
- Air cargo fleet expanding (wide bodies, comm C-17)
- Air freight providers lead the way.
 - Robotic loading
 - Pervasive TAV, containerization, inspectability
 - Integrated, end-to-end, information-based system

1/7

Transmodal Force Projection

Assuming TAV and Extensive Containerization



2/7

Total Asset Visibility

- Continuous control over units, people, and materiel
 - Transmodal; functions on land, at sea, in the air
 - From CONUS origins to overseas employment
 - Precise information on locus, condition, custodian
 - Rapid adjustment of flow, swift replenishment
- *Sine qua non* for:
 - Significantly more rapid force projection
 - Efficient SUO (highly aware, agile tactical elements)
 - Adoption of a distributed indirect fire system
 - Scrapping just-in-case logistics for just-in-time
 - Altering drastically the teeth-to-tail ratio

3/7

CONTAINERIZATION

- JIT logistics entail TAV and extensive containerization
 - Military now lags commerce
 - Gap will probably widen
- Trends dictated by costs:
 - On North Atlantic, shipping is 10-15% of costs
 - * Average ship now 2500 TEU (20 ft equiv units)
 - * Newer ships 5-6000 TEU
 - Terminal (port) operations are 85-90% of costs
 - * Fastest terminals crane-off 150 containers/hr
 - * New ships outmode current terminals: ~ 2 days!
- Hence, strong incentives for:
 - More durable, lighter containers
 - High speed unloading methods

4/7

STACK 15
P.1

The FastShip Initiative

- Commercial ship trends are generally adverse for AAN:
 - Larger container carriers needing mega-ports
 - Fewer US flag carriers; current status:

	Owner	Total	US Built	Age<16 (US Built)	Age>6(US Built)
Containerships	USG	6	5	0 (0)	0 (0)
	Pvt	76	37	41 (10)	1 (1)
RO/RO	USG	35	8	5 (0)	0 (0)
	Pvt	37	15	20 (7)	0 (0)

- FastShip™ is U.S. venture to ship high-payoff containers:
 - In broad-beam hulls with water-jet propulsion
 - All cargo in-hold, RO/RO using air-cushion pallets
 - At speeds above 35 knots on North Atlantic, Pacific
 - Appears to have military potential:
 - * 1 Fce XXI Hvy Task Force & 2 AirCav Sqdns @ 38 kts
 - * Range 1050 miles per day, or 7300+ miles per week, all weather

5/7

Transmodal Shipping Technology

- Containers of composites
 - E.g., thin-shell polycarbonate
 - * Tensile strength 9,000,000 psi
 - * Strength compress, flex ~ 13,000 psi
 - * Shear modulus 114,000 psi
 - * Elasticity modulus 340,000 psi
 - Less tare, better system conformity
 - Usable as shelters; easy to cover, conceal on land
- Means to load/unload containers 4 to 6 X faster in port
 - E.g., ALICON airlifted pallets for containers
 - Graceful interfaces with trucks, rail cars
- Current thrusts aimed at FastShip™, but:
 - Appears useable for conventional ships
 - Adaptable for military requirements in austere ports?

6/7

STACK 15
P2

Opportunities for AAN Exploitation

- Explore CRAF support for AAN initiatives
 - LIFR, Combat Casualty Support, parachute delivery
 - Carbon-winged, up-engined commercial C-17
- Experiment with new air and sea containers to ascertain:
 - Relevance for rapid deployment
 - Adapability as in-theater shelters
 - Capacity for hardening against ballistic, WMD threats
 - Applicability for munitions shipping (e.g., LIFR)
- Cooperate with commercial carriers to develop:
 - Interoperability of info management, pallets, containers
 - Practical, CINC-exercised contingency plans
- Adapt commercial systems as primary deployment using:
 - Airlift, for the AAN C+1 division and the C+3 corps
 - Sealift, for sustainment and follow-on echelons

7/7

Civil Reserve Airfleet

Federal Funds for Standby Readiness

- **Mainly PAX**
- **Need to coopt freight/express shippers**
- **Air-to-air refueling useful**
- **For freight aircraft, paratroop doors oxygen bottles for crew very important**
- **Ought to be possible to design for PAX inbound to theater, casualties outbound**
- **Wing-loading for passenger aircraft?**
- 1/4 • **Clam-shell doors, rear loading?**

C-17 Commercial Version

- C-17 requirement from top-down OSD intervention
 - Neither USAF and USA wanted program
 - AAN will need more than current program provides
- Planned commercial version scraps military features
 - CRAF could subsidize their retention
 - CRAF could subsidize enhancements
- CRAF could equip with polycarbonate composite wing
 - Lighter, more efficient, hence extended range ~25%
 - Stronger, less likely to have stress problems
 - Could be equipped with MEMS maintenance aids
- CRAF could provide modern engines
 - Further gains in fuel efficiency, speed, and range
- 3/4 • Commercial C-17s could become a mainstay of AAN

Civil Reserve Air Fleet (CRAF)

- US government pays airlines to modify planes to meet wartime requirements
- AAN ought soon to become active re CRAF:
 - The aircraft built over the next decade will be those flying in 2016
 - Unless incentivized, airlines unlikely to buy:
 - * Clam-shell doors for rapid load/unload
 - * Provisions for parachuting in flight
 - * In-flight refueling kits
 - * Exterior-load hard points

2/4

Launch-in-Flight RAH-66

- **How about launch-from-internal load via tow-to-flight, or parachute-to-flight, or paraglide-to-FARRP?**
- **AAN should vigorously experiment with intercontinental attacks to control land!**



4/4

Strategic

AAN Map

STACK 16
P-1

Situational Awareness

Means, mechanisms and procedures for providing every member of any team, at every echelon, with access to the information he or she needs, when they need it, and can use it.

Situational Understanding

The ability of a team to use situational awareness to advantage, to comprehend information and to act upon it to execute the intent of the commander.

Informatics for Teamwork

- Reconfigurable C4I based on internetted networks of networks with distributed nodes
- Personnel and equipment monitoring
- Small unit tactical communications
- Small/micro RPV's and robots at small unit level
- Imbedded training/learning loop
- Integral jamming, cloaking, deception
- Asset visibility and monitoring

Situational Awareness/Understanding is NOT

- Intelligence — timely information about the enemy and the environment is necessary but not sufficient
- Every team having access to all information: function and practicality must govern informatics design
- A charter for uncoordinated action independent of the intent of the commander

VIRTUAL MINEFIELDS ("NO OPERATION ZONES")

- An operational concept: using systems of systems to create large areas in which enemy military operations would be nearly impossible to conduct.
 - zones would be large enough to be operationally useful (e.g., 20x20x10km)
 - zones would be moved around a region rapidly
 - used on an "advance warning" or "no notice" basis
 - enemy activity would be detected, targeted and disabled (not necessarily destroyed)
 - zones may not be entirely leak proof
- Applications of these "no operation zones"
 - shape the battlefield (e.g., channel enemy forces)
 - barriers to protect friendly or allied units
 - containment of enemy military operation
 - peace enforcement
 - demonstration of overwhelming U.S. military technical power
- Development characteristics
 - based on "systems of systems" (e.g., sensors, C2, jammers, weapons)
 - encourages a broad range of technology development efforts
 - multi service

AAN Map

Med Support In 20 Years.....

- **Combat forces 33% of current manning**
"Conserve the fighting strength..."
- **Firepower 100% that of present threats**
"Realigned casualty prediction models..."
- **Teeth-to-tail ratio (In-theater) > 1.0**
"Hyper-rapid evac to CONUS or haven..."
- **Health care as needed vice per capita**
"Total health accountability, responsiveness..."
- **Project care forward vice evac to care**
"Combat telemedicine to point of casualty..."
- **Acquisition fueled by civil health-care system**
1/10 "Demand driven, exploiting advanced tech..."

Future Combat Casualty Care

- **Sit Understanding:** forestall, locate casualties
— PSM component of C⁴I
— Triage from instant of impairment
- **Mentor first-care provider**
— Bandwidth as important as bandages
- **Stabilize far forward**
— Tele-treatment, tele-surgery
- **Evacuate rapidly, preferably to secure haven**
— Downsize, harden in-theater med presence
- **Med-holds in CONUS only**
2/10 — All convalescence, rehabilitation

FUNCTIONS

TELEMEDICINE	BOTH	INTELLIGENCE
patient record patient vital signs radiograph/med imagery audio/visual sensings hi-fi video conferencing medical education	collaborative interpretation whiteboard annotation quality images real-time interaction measurement volume rendering	dissemination intel prep battlefield graphics/ maps troop movements materiel deployments materiel characteristics

LOCUS

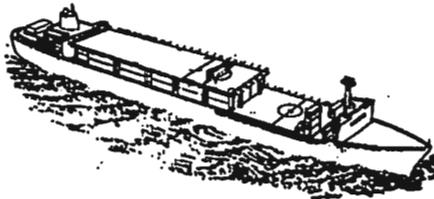
Expertise in both communities resides in CONUS

COMM REQUIREMENTS

Global Sonet/ ATM OC-3 w/ multi-level security

3/10

**ARAPAHO-MED:
Reconfiguring AMEDD Field
Facilities for Operating at Sea**



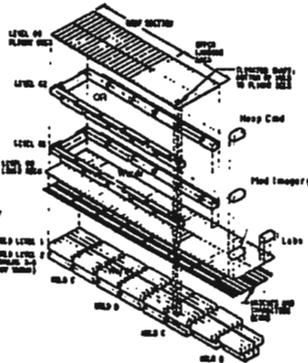
4/10

ARAPAHO-MED

Concept for
Container-Based
MASH

(Mobile Army Surgical
Hospital)

Unit can operate at sea
or deploy
in containers
on land



5/10

Stabilization Enroute to CONUS



6/10

Hyper-fast Medical Evacuation

- **Delta Clipper** is commercial venture dealing in critical cargo, key persons
- Could evac from any helipad direct to any tertiary care hospital in CONUS
- Max flight time > one hour
- 120 feet X 60 tons
- Civil Reserve Rocket Fleet (CRRoF)?



DC-X...McDonnell Douglas & Boeing
1/3 scale model of Delta Clipper...
10 feet tall, 41,000 pounds...35 feet
tall...1700... flown 7 times. Prospects:
March 25 500k feet; 45 min to CONUS

7/10

**DARPA Medical Technology
for Combat Casualty Care**

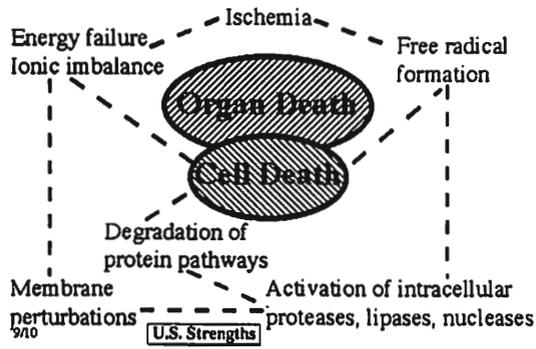
- **Immediate Casualty Awareness**
— Casualty location, triage, treatment
- **Accelerated Medical Response**
— Remote surgery, life support, imagery
- **Enhanced Medical Treatment & Training**
— Combat informatics, trauma simulation

\$ million						
FY94	FY95	FY 96	FY97	FY98	FY99	Total
13.7	54.7	51.0	29.5	17.6	5.6	172.1

8/10

Steck 18

Anti-trauma Bio-Engineering



Trauma Hibernon

- High-risk pharmacologic syntheses
 - molecular modeling, cell-level agents
 - program ~\$50 million over 5 years
 - Use Special Agreements Authority
- Drug-induced tolerance to ischemia despite exsanguination, tissue hypoxia, and acute systemic shock; remote controlled injection
- Prevent irreversible cellular injury, restore homeostasis
 - Cessation of energy consumption
 - Block cell detractors
 - Stimulate natural defenses

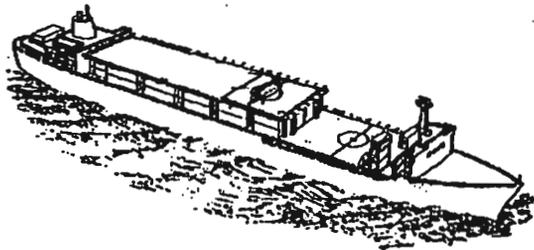
10/10

AAN Map

AAN Modular CSS

**No trucks, no tents, no shelters except
ISO containers**

**Train and fight from containers, at sea
or on-shore**



AAN Modular CSS

- **Army's ARAPAHO study of the '80s demonstrated that personnel and vehicle cost avoidance will pay for containerizing.**
- **Concept has strategic reach, plus tactical survivability in that containers can be entrenched.**

Arapaho-Med

M.O.

AAN Map

Communications Technology for Teamwork

- Reliable connectivity in restrictive environments
- Able to operate amid hostile SIGINT /jamming
- Network widely dispersed teams
 - 70 teams, with 7-14 soldiers per team
 - 200 km x 200 km area of operations
 - Scaleable to larger areas, more teams
- Interoperable with legacy comm systems, e.g.
 - SINGARS
 - EPLRS
 - Mobile Subscriber Equipment (MSE)
- Field-worthy
 - Light-weight, low-power drain, user friendly
- Affordable (<\$2000)

15

Coping with Enemy Information Warfare

Current Weakness	Required Technology
Reliability in restrictive environments <i>"match radio to the place"</i>	Diversity, redundancy <ul style="list-style-type: none"> • Network <ul style="list-style-type: none"> • Multi-band sets Robust, adaptive nets Innovative relays
Limited COMSEC <i>"make the signal hard to find or read"</i>	New LPI/LPD Means <ul style="list-style-type: none"> • New waveforms • Spread spectrum Increased/variable bandwidth Directional/nulling antennae Power control
Range <i>"tailor the net for the need"</i>	Novel waveforms, variable bandwidth, antennae

3/5

Communicate what?

Voice	Calls for fire	Intel
Position	Telemedicine	PSM data
Orders	Maintenance	Resupply
Data, Voice, Video		
in		
Built-up areas		
Coniferous forests		
Triple-canopy jungle		
Mountain		

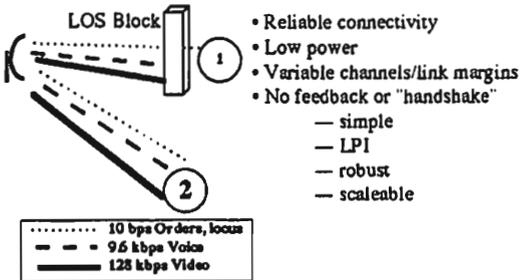
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DARPA R&D for Tactical Comms

- Restrictive environments
 - Range and bandwidth; LPI, LPD, AJ
 - Combatant tracking for IFF
- Ground-based relay improvements
 - Better range, operational life, survivability
 - Portability and ease of deployment
 - Affordability
- Protocols
 - Adaptive, dynamic connectivity
 - Variable network control
- Integrated navigational capability
 - Time of arrival
 - Spread spectrum ranging

45

Parallel Channelization



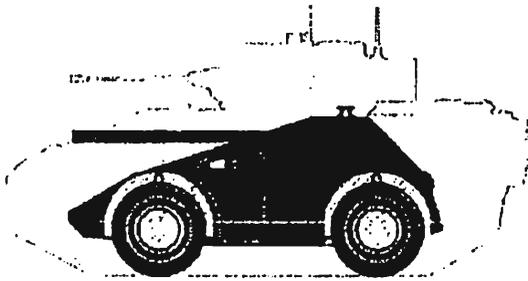
- Reliable connectivity
- Low power
- Variable channels/link margins
- No feedback or "handshake"
 - simple
 - LPI
 - robust
 - scaleable

Multi-channel, all digital transceivers

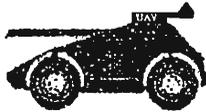
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AAN Map

Electric Combat Vehicle (ECV)



1/12



- Hybrid electric, crew of 2
- Fly-out infantry support wpa
- Slaved UAV
- Can tow arty/mortar container

Electric Direct Fire System (EDFS)

ECV for Military Operations in Built-up Areas

- Squad of 7 (two teams)
- Hybrid electric, crew of 2
- Slaved UAV
- Can tow arty/mortar container



SquadPod

3/12

TECH for TEAMWORK: SCOUTER

Air Cavalry Regiment

-Two component

vehicle: robot helo + ATV

-Crew of two:

Pilot/RSTA operator • scout/driver •

-ATV is ultra-lite ECV



5/12

Sit Map

Status of the "Ground Combat Platform"

Army approach:

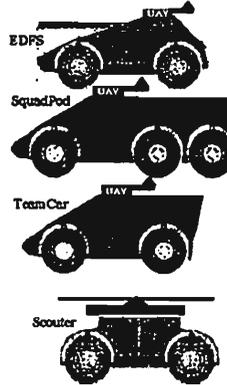
- R&D objective: a common AFV chassis
- Commonality of components, structures, information systems, maintenance, training
- Not unlike the Armored Family of Vehicles program of the '80s
- Plan is to keep current platforms in service until R&D bears fruit
- Army prepared to fund required O&S
- Current proposed designs: 55 ton
- Desideratum: 40 tons, lower if feasible

7/12

Electric Combat Vehicle

- Weight < 10 tons
- Hybrid electric/fossil fuel
- Fuel use 25% that of BFV @ 2X radius, 2X speed cross country
- Acoustic/thermal/visual signature reduction
- Active armor
- Active suspension
- Electric guns, DEW
- Mated to UAV for RSTA

2/12



TECH for TEAMWORK: SCOUTER

Air Cavalry Regiment

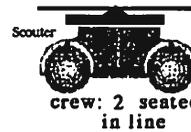
• Helo mated for airmobile scouting

• Vehicles separate for ground scouting

-Helo performs RSTA functions overwatching ATV →

-ATV is double-ended, RSTA rigged, functions of driving, RSTA ops shift front-to-rear for "scoot"

4/12



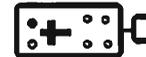
crew: 2 seated in line

TeamCar for Airborne Division

- ATV, an AECV with a small, RSTA UAV
- ATV mounts direct fire w
- UAV control by Pilot •
- Assigned driver •
- Team of four for OP(s) •
- TeamCar tows a mortar pod
- Soldiers are parachutists; vehicles are air-dropped



TeamCar



6/12

Sit Map

AAN Map

Benefits of Common Chassis Approach

- Some improvement in strategic mobility
- Acquisition cost for "family" is reduced
- Cost of O&S (operation and sustainment) lower
 - Less fuel required (hence less fuel trucks)
 - Fewer spares overall
 - Simplified training
 - Fewer personnel overall
- Lower costs in sustainment base from privatization (perhaps) - acquisition reform, not modernization

8/12

There are Alternatives...

Approach A: Work the present system

- Much lighter, innovative tracked vehicles
- TRADOC sets requirement in which force projection/early entry dominates
- Creative arrangements for shared RDA costs

Approach B: Coopt commercial designs

- Non-traditional suppliers (Deere, Caterpillar)
- World-wide spares/maintenance support
- Business likely to respond to either requirements for tracks or for wheels

9/12

BUT...

- Commerce has proved that large numbers of heavy vehicles, wheels and tracks can be procured, operated, and sustained well below Army experience
- Testing by Germans supports 2 and 3 man crews
- Conventional design-weight is driven by armor to protect crew. Surely there is a better answer:
 - In information system design and automation
 - In active as well as passive protection

11/12

No Choice Provides Easy Answer

Approach A: Where will the Army get the money?

Approach B: Commercial tracks lack the speed and maneuverability Army seeks, and commercial wheels have failed all Army evaluations

10/12

Suggestion

An acquisition reform initiative to invite industrial participation in the determination of requirements for AAN combat vehicles...

12/12

Development

AAN Map

Technology for Teamwork

- Portable sources of energy are essential for sensors, communications, and robots (including flying vehicles) used in support of small, tactical teams
- Lithium batteries — currently in vogue — are expensive, dangerous, heavy, and difficult to dispose of
- There are several promising designs for fuel cells that are likely to supplement batteries in the next decade.
- Beyond fuel cells lie very small engines, micro-electric mechanical systems (MEMS), that could furnish the antithesis of lithium batteries: very small, light, cheap, innocuous sources of mechanical and electric energy.

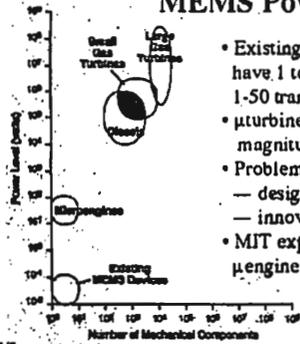
1/5

MEMS Turbo-generators

- μ fabrication of refractory ceramics enables shirt-button size gas turbines and generators (~.6cc)
- Power densities (HP/unit volume) ~ full-size engines (100 watts/cc)
- Costs could be very low in volume
- μ engines enable:
 - On-person electronics
 - μ UAV and fly-out weapons
 - "Refuel-able" power cells

2/5

MEMS Power



- Existing MEMS devices typically have 1 to 10 components, and 1-50 transistors
- μ turbines are an order of magnitude more complex
- Problem is fabricating parts
 - design unprecedented
 - innovative forming techniques
- MIT expects to have an operating μ engine by year 2000 @ 20 watts

3/5

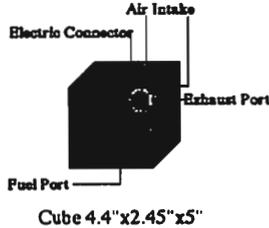
μ Engine vs. Conventional

	1st μ	Next μ	Auto	Helo
Power (kw)	0.02	0.1	50	500
Airflow(g/sec)	0.2	0.6	330	2500
Specific Fuel Cons (kg/hr/kw)	0.45 ¹	0.28 ²	0.28 ²	0.38 ²
Power/Air Flow (kw/kg _{air} /sec)	84	140	151	200
Power/Wt (kw/kg)	20:1	100:1		5:1

¹ H₂ fuel
² JP-8

4/5

μ Turbo-generator in BA-5590¹ case



- 7600 watt-hours with butane fuel
- Typical consumption: 25 watts for 300 hours
- 200° F exhaust without forced ventilation (dissipates in inches)
- Noise above human hearing

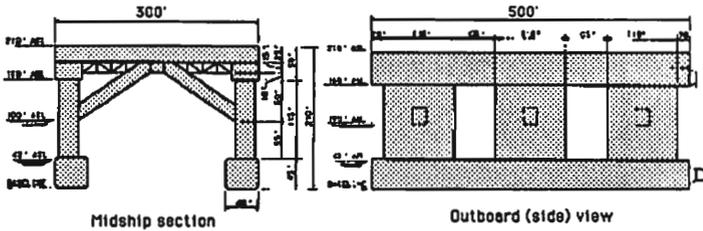
¹ Army Li-SD₂ Battery (@ \$12,000)

5/5

Stack 23

Mobile Offshore Base

- Module 300' wide X 500' long
- 6 modules = C-130 airfield; 10, C-17
- MNS signed by CMC, CINCSOC, CINACOM and USCINCSO (FY95)
- Cost/module (DARPA estimate): \$372M



Logistics Over the Shore (LOTS)

- Landing Ship Quay/Causway (LSQ/C)
 - Modified Very Large Crude Carrier
 - 15 knot speed
 - Ballasted to seafloor off beach to serve as stable pier head, recoverable
 - Carries up to 10,000 feet of raised causeway, cranes, pipelines, conveyor belt for containers
- Deployed in 72 hours up to seastate 5

AAN Map

Strategic

Stack 2f

Exactly where?

- For land warfare, GPS — unaided — is an unreliable and vulnerable mechanism
- GPS is commercially available to friend and foe: in searching for a combat edge, land forces need better means for x,y,z
- GPS is weakest where land forces need it the most: in built-up areas, mountains, jungles; with a small, dismounted team; for Personnel Status Monitors.
- GPS is susceptible to jamming. A 100 watt jammer can deny signal to commercial sets out to 100 km
- Improved GPS is possible: e.g., more accurate clocks, better antennae, and integration with alternative position-fixing mechanisms such as inertial nav systems, or radio signal processing. These deserve high place in AAN priorities

1/3

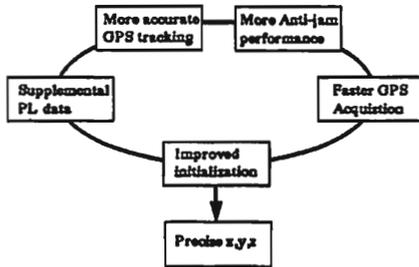
INS?

Inertial Navigation Systems can be coupled with GPS but INS sets have been big, expensive, power-eaters inappropriate for small teams. Situation is getting better:

	<u>1987</u>	<u>1996</u>	<u>2002</u>
Weight (lbs)	47.3	18.0	7.0
Volume (in ³)	1418	480	100
Power (watts)	141	40	25
MTBF (hrs)	3500	6000	8000
Cost (\$k)	100	70	15

2/3

Synergy via Redundant PLR



3/3

AAN Map

Unmanned Aerial Vehicles (UAV)

- Small aerial vehicles for RSTA ought to be integral to every tactical team
- Command and control must reside in team
- UAV for AAN should be largely robotic, that is, able to take and keep station with minimal human intervention from the team
- AAN should actively seek new UAV designs optimized for small unit operations

1/5

A Spherical UAV

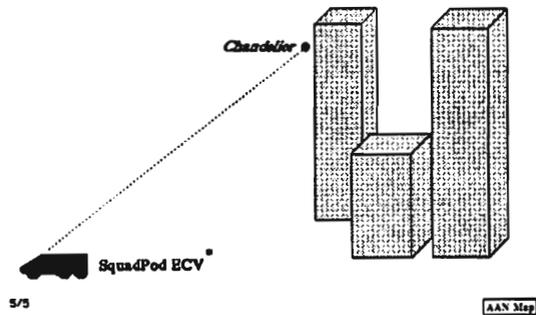
- Geodesic (made of light, straight structural elements), beachball-size sphere that moves freely in x,y,z — optimized for hover above small units
- At each intersection on surface, a MEMS-jet is mounted normal to surface of sphere; thrust is metered to position UAV
- At center of sphere is fuel tank and processor(s), sensors and comms



3/5

- Activated set of linear surface elements forms reflective dish for RF relay, sensors

A "Hummingbird" UAV for MOUT



5/5

CHANDELIER

overhead

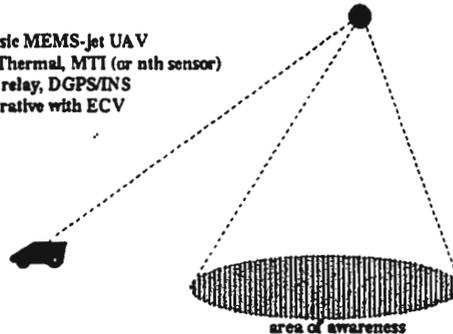
- UAV virtually-tethered to ECV
- Powered by micro-turbines
- Radio relay, DGPS
- "Constant stare" sensor(s) and "report change" algorithm



2/5

CHANDELIER offset

- Geodesic MEMS-jet UAV
- SAR, Thermal, MTI (or nth sensor)
- Radio relay, DGPS/INS
- Cooperative with ECV



4/5

Modernized Artillery

- Long range fires from USAF, USN, sea-based MRLS and ATCMS
- Close, responsive fires from autonomous, distributed, un-manned fire units
- Calls-for-fire optimized for optimum responsiveness sensor/observer-to-target
- Cost effectiveness driven by target-worth and tactical urgency as well as P_h and P_k

1/15

M.O.

Army Research Laboratory Integrated Soldier Engagement System Concept

- Individual soldier becomes a node in a distributed interactive weapon system
- Individual soldier is equipped with fire direction system
 - Components:
 - Fire direction unit: sensor suite & computer
 - Communications network
 - Weapon for personal defense
- Weapon systems distributed around battlefield in weapons pods
 - Semiautonomous
 - Networked
 - Remotely emplaced:
 - air drop, robotics, cargo projectiles, light vehicles
- Overarching C4I network

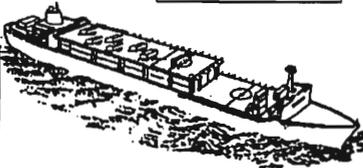
3/15

Modernized Artillery

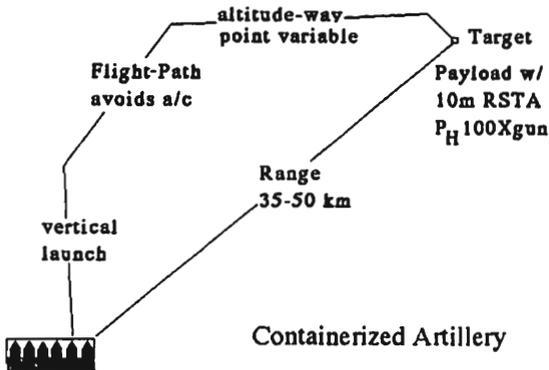
An AAN "arsenal ship:" a fast commercial container ship, with 6 to 8 launchers, ammunition supply, and vehicles for offshore operations.

Each MLRS ripples 12 rockets < 1 minute, 5000 bomblets on 30 to 60 acres at ranges at ranges up to 32 km. Or, two ATMS missiles ~45 km.

In high-hazard areas MLRS can be off-loaded onto LCU or other small craft



5/15



7/15

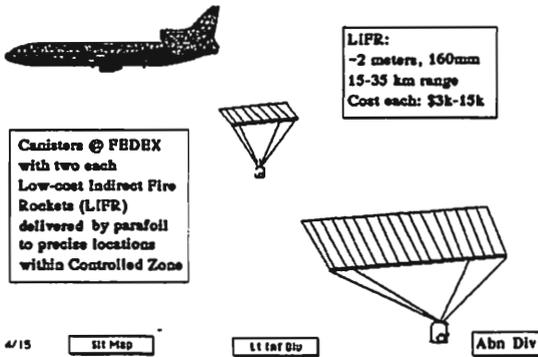
Even in the Gulf...the intelligence system consistently came up short. All of the range, precision and lethality that a firepower system brings to the battlefield cannot be fully exploited unless the eyes of the system can isolate the most lucrative targets within a target array, then pinpoint those targets within a space smaller than the killing radius of a weapon, and deliver the weapon before the target moves or goes to ground.

To the infantryman seeking to kill the enemy, the source of ordnance exploding to his front is irrelevant. He must receive the most effective munition when and where he needs it. He must be able to mix firepower from all sources and apply all fires in concert...

In a small-scale war of intervention, tempo and speed will dictate that light, highly mobile infantry forces make up the majority of the force...In wars of intervention on the higher end of the scale, firepower must be used lavishly to win quickly at minimum cost... The survival of the ground force will be most dependent on a protective aerial umbrella... R.H. Scales, *Firepower in Limited War*, 1994

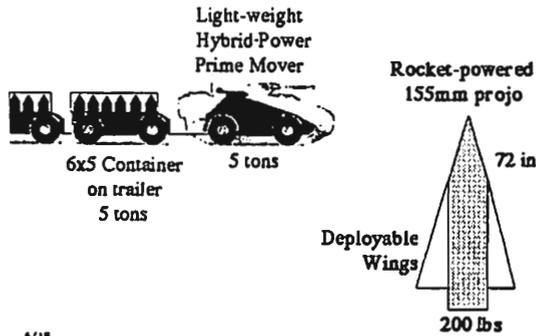
2/15

Modernized Artillery



4/15

Containerized Artillery



6/15

Containerized Artillery

- Flight vehicle design-to-cost \$20k
 - Uses GFE 155 cargo rounds @ 100X effectiveness
 - 30 rd container ~ battery/5; 2-n rd containers feasible
 - Each rocket is independently targeted
 - Projectile is gas-launched, vertically boosted to 1-3 km altitude, glides thru flight to target, then dives
 - Velocity 200m/sec, or 2 minutes to fly 24 km
 - Accuracy on target @ 10 meters (GPS+INS)
 - Prime mover is hybrid electric vehicle; fuel efficiency 200-300% better than current vehicles
 - System air-droppable, deployable in C-130, CH-47, V-22
 - Container electric powered, kevlar protected
- * 1,000,000 rounds in inventory

8/15

Development

AAN Map

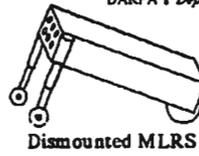
DARPA has independently evolved a concept for a "deployable firepower system"

- Small, lightweight, low profile
- High accuracy
- Air droppable
- Major manpower savings
- Remote-control operation
- Capable against multiple target classes
- Production cost comparable to other weapons
- Responsive fires out to ~ 20 km

9/15

Containerized Artillery

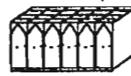
DARPA's Deployable Firepower System



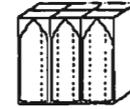
Dismounted MLRS



Multiple 120mm Mortars



Vertical-launch Mini-missile



Vertical-launch Smart Bus for 155mm artillery rounds

10/15

Containerized Artillery

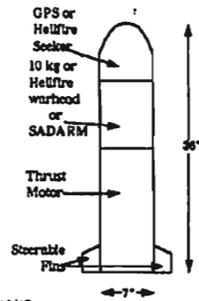
DARPA's Deployable Firepower System

	MLRS	Mortar	Mini-missile	155mm Smart Bus
Range	40+ km	~10 km	25+ km	40+ km
Accuracy (max range)	~150m (OPS soon)	~100 m	GPS	GPS
Warheads	DPICM mine	unitary STRIX	unitary STRIX SADARM	all 155mm proj BAT
Shots/containers	6	96	1-24	1-6
Size	23x5x4'	6x4x5'	4'x3'x3' (for 24)	5'x3'x4' (for 6)
Weight	~5,000 kg	~5,000 kg	~150-2,500 kg (1 to 24)	~500-2,500 kg (1 to 6)

11/15

Containerized Artillery

DARPA's Deployable Firepower System



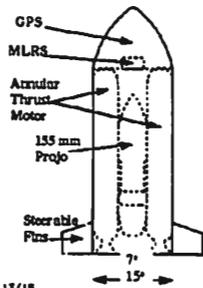
Mini-missile Concept

- Vertical-launch via gas bag
- ~20 km range
- Total weight < ~50 kg
- Time of flight ~1 min/20 km

12/15

Containerized Artillery

DARPA's Deployable Firepower System



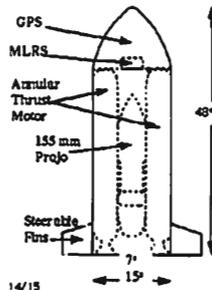
Smart Bus for 155 mm Concept

- Vertical launch (gas bag)
- 100 lb. warhead, 40+ km range, GPS accuracy
 - Unitary, DPICM, SADARM, BAT
 - Max use of existing components
- Total weight < 200 kg
- Time of flight ~1 min/20 km

13/15

Containerized Artillery

DARPA's Deployable Firepower System



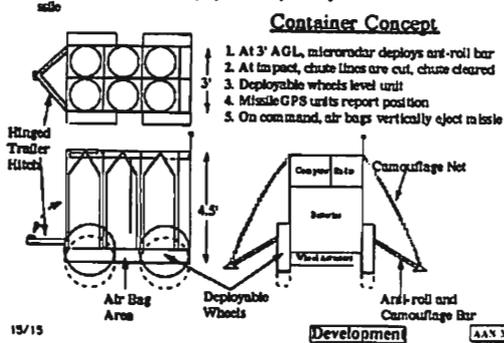
Smart Bus for 155 mm Costs

- Missile Motor \$5k
- 155 projo* \$1-5K
- GPS (w/INS) \$1k (\$15k)
- Missile shell, air bag \$5k
- \$12k (\$26k)

14/15

Containerized Artillery

DARPA's Deployable Firepower System



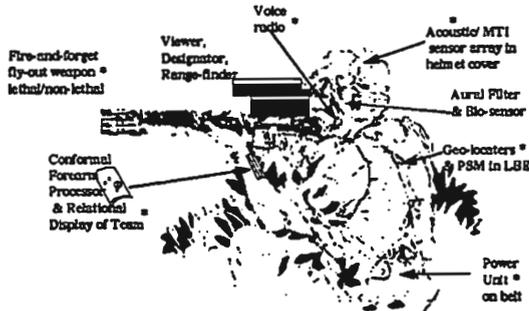
Container Concept

1. At 3' AGL, microcircular deploys anti-roll bar
2. At impact, chute lines are cut, chute cleared
3. Deployable wheels level unit
4. Missile/GPS units report position
5. On command, air bags vertically eject missile

15/15

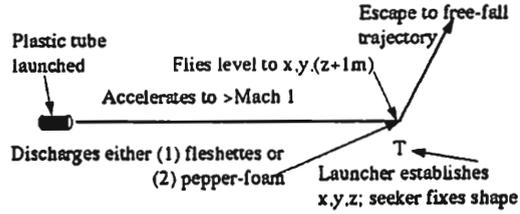
Development AAN Map

TEAM-MEMBER, 2016



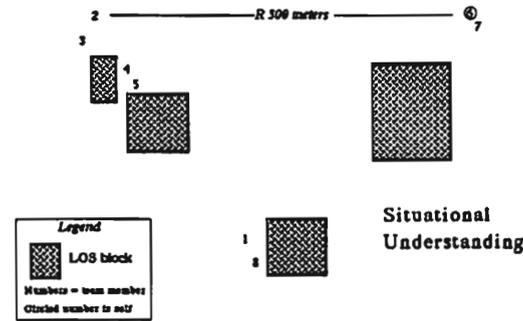
1/6

Fire & Forget Fly-out Weapon
A Weaponized Micro-UAV

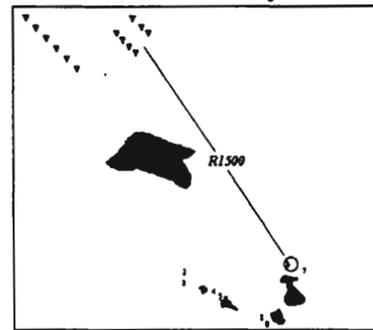


2/6

Relational, Forearm Conformal Display
Voice and Touch Activated
6 inches wide X 5 inches high

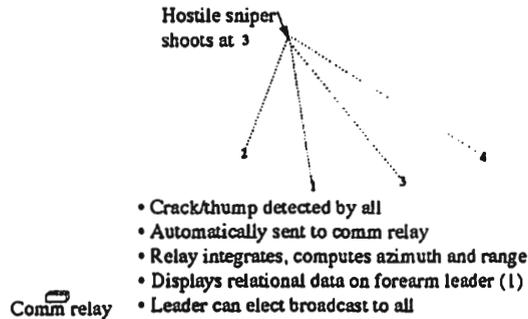


3/6



4/6

Team as Sonic Array



5/6

ACOUSTIC TECHNOLOGY

Broader Implications?

- Further development of acoustic technology and systems would provide new military opportunities in weapons and reconnaissance. E.g.:
 - Reconnaissance: sensors
 - Targeting: UAV in counter battery mode
 - Smart weapons: Anti armor/anti vehicle
 - New weapon types: anti-helicopter smart munitions
 - Battlefield deception: noise makers replicating weapons fire
 - Tactical surprise: silences on all weapons
- Progress has already been made in some systems (e.g., UGS, BAT). Broad application of acoustics could have the following impact:
 - present potential adversaries with more complexity on battlefield
 - complicate adversary's war planning and assumptions.
 - provide opportunities for major surprise (i.e., adversaries may not immediately understand how their forces are being attacked, and thus are slow to counter).

6/6

Stack 28

Trained & Learning

- Trained to a high readiness baseline
- Capable of learning, from that baseline, to rapidly adjust to the environment
- Conduct STOW rehearsals in any location, for all combatants, with embedded systems
- TES and AAR capabilities embedded in C4I
- TRADOC capabilities distributed directly to operational area

1/21

Technology for Teamwork Improved Recruiting Systems

Implicit in the AAN concept is fewer, more capable soldiers. Hence recruiting, classifying, and selecting these becomes a high pay-off undertaking. AAN must:

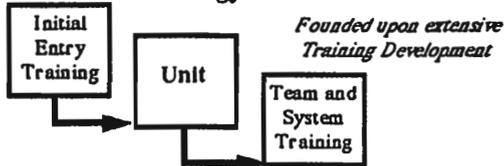
- Meet requirements for technically sophisticated members of small teams
- Match each soldier's abilities to his/her job
- Retain apt soldiers and develop them into leaders

To do so, AAN must be able to:

- Measure aptitude with certainty
 - Psychomotor and spatial tests
 - Assessments of temperament and interests
- Accurately predict performance as a team-member

3/21

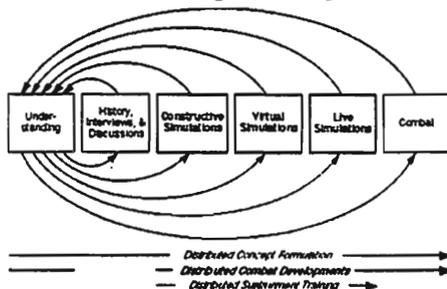
Technology for Teamwork



- Team training rests on two principles:
 - Training can and will be delivered "just in time"
 - Training progresses daily, before and during combat
- TRADOC must assure availability for team training of:
 - Enablers (job aids, devices, simulators, simulations)
 - Embedded training in all combat systems
 - Robust distance learning systems

5/21

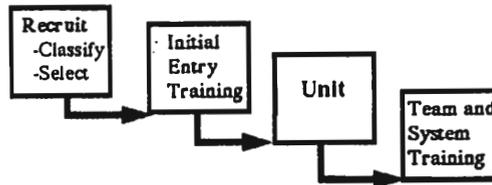
Simulation in Support of Combat and Training Development



7/21

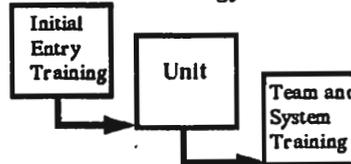
Technology for Teamwork

AAN must aggressively pursue R&D into the social and behavioral sciences, and press forward with training technologies.



2/21

Technology for Teamwork



- Diverse unit equipment, in varying stages of modernization
- IET (institutional training) provides baseline socialization and core skills
- Unit training, within the context of small team, conveys requisite skills and knowledge for proficiency in combat
- TRADOC's role: training development, certification, doctrinal and materiel modernization

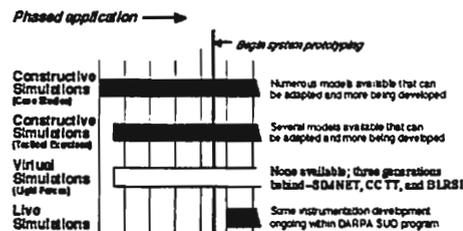
4/21

Technology for Teamwork Carefully designed units

- Organizational design must be proofed in a series of increasingly demanding simulations (constructive, virtual and live)
 - E.g., recent experiments in small team design at IDA pointed up need for disciplined understanding of task distribution, sensor management, data flow, human interfaces with information systems
 - The effort can both advance behavioral understanding and facilitate incorporation of new insights
- AAN unit design will require extraordinary efforts by Army Research Institute (ARI), Walter Reed Army Institute of Research (WRAIR), AMC's Soldier Support Command, and TRADOC

6/21

Simulation in Support of Combat and Training Development



8/21

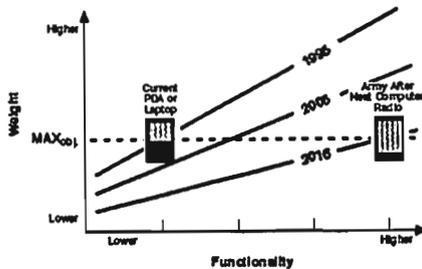
Utility of models and simulations to address tactical echelons

	Constructive Simulation	Virtual Simulation	Live Simulation
Battalion	●	○	●
Company	●	○	●
Platoon	●	○	●
Squad	●	○	●
Team	●	○	●
Individual	●	○	●

● Good fit ○ Good fit, if available

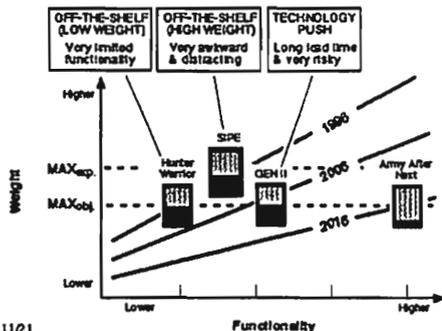
9/21

The Army After Next individual and small unit computer/radio



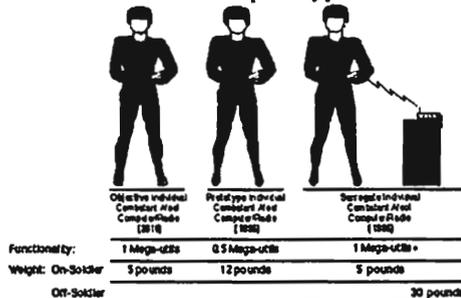
10/21

Prototype approaches to date



11/21

The virtual prototype



12/21

The virtual prototype



- Uses low risk 1996 components to emulate 2016 capability, weight, and size.
- Can be "tactically" employed.
 - In a variety of terrain
 - Against an array of 2016 threat forces
 - In conjunction with all appropriate Army After Next combat support systems
 - By a variety of individuals - users, subject matter experts, decision makers, etc
- Can be "explored" several times a week, week after week
- Individual combatant's computer/radio software can be modified on the fly

13/21

The functionality gap (it's significant!)

What we are doing...
[Digitization]

- Providing a capability to submit a standard fire request with a digital entry device [... a better "telephone"]

What we should be doing...
[Information/Process Data Management]

- Provide capability to manage multiple requests simultaneously [increased combat power]
- Provide means to optimize individual/small unit internalization of remote sensors [increased combat power]
- Provide means to optimize individual/small unit internalization of remote fire [increased combat power]
- Provide means for enhanced attack helicopter/small unit coordination [increased combat power]

14/21

Other knowledge gaps & uncertainties

- How do we balance/optimize the utility of a small computer/radio to meet the needs of:
 - The individual as an INDIVIDUAL
 - The individual as a MEMBER OF A SMALL UNIT
 - The individual as a LEADER OF A SMALL UNIT
- How do we optimize the utility of a digital map for the individual and small unit leader?
- And beyond the individual computer/radio:
 - What are the optimal TTP for the employment of a fire and forget rifle?
 - How do we substantively reduce the individual soldier's combat load?
 - ... end on and on.

15/21

Another dimension of virtual prototyping

The Army After Next Strategic Environment



Type Exercise	Terrain	Threat	Combat Support	Frequency
Live Simulation	Single type	1 or 2 types	Conventional	1 per year
Virtual Simulation	Multiple types	Multiple types	Class 2016	1 per week

16/21

Another dimension of virtual prototyping

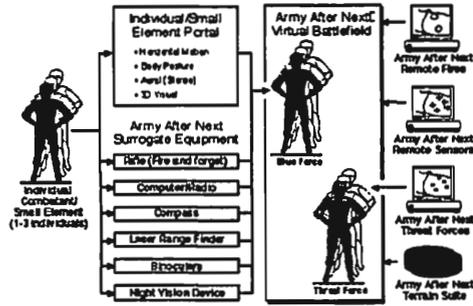
Army After Next Battle in Urban Terrain



Terrain Representation	Size	Geo-location	Structural components	Graphical fidelity
ADUT Site (Live Simulation)	Very small village or town	Offen in Germany	Single layer concrete block	Number and location fixed
Virtual Urban Terrain (Virtual Simulation)	Unlimited	World-wide	Unlimited	Any number and location

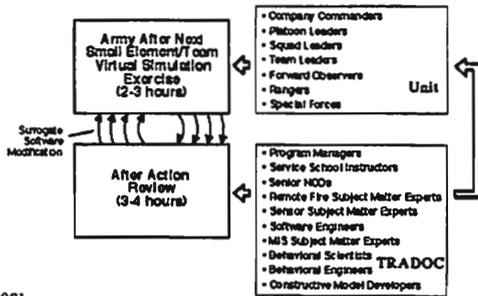
17/21

AAN virtual concept exploration



18/21

CONCEPT EXPLORATION



19/21

Problem: Force XXI ≈ Heavy Force

- If objective is to learn from Force XXI in developing AAN, imperative to apply digitization to light forces, experiment with networking and comms minus Abrams, Bradley AFV.

- Dismounted Battlespace Battle Laboratory (DBBL) relatively primitive compared with Mounted Battlespace Battle Lab

20/21

A suggested approach

DBBL develops Force XXI, DARPA/IDA develops AAN

- DARPA Small Unit Operations (SUGO)
- DARPA Synthetic Theater of War (STOW)

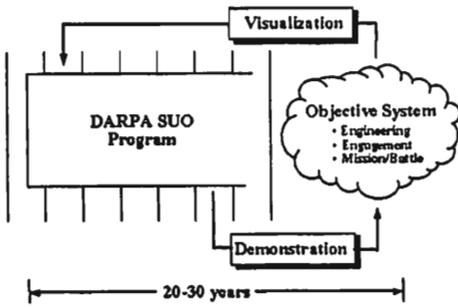
	FT97	FT98	FT99
Institute for Defense Analysis Executive Center WARI/WDAIS	Develop/employ Army After Next battle team virtual concept exploration facility	Expand to Army After Next battle team concept exploration facility	
FOCUS	Engine Performance	Create equipment and logic simulation of Army After Next concepts	Create equipment and logic simulation to test level to determine test instruction alternatives
Dismounted Battlespace Battle Lab (DBBL)	Develop/employ Force XXI battle team exploration facility	Expand to Force XXI battle team exploration facility	

- STROOM/Westside track (Wan-98)
- STROOM/TRADOC Battle Lab Reconnaissance Battle Lab (RBLB)

21/21

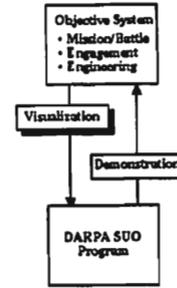
AAN Map

The DARPA SUO Program

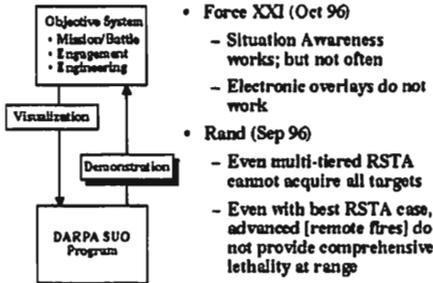


Extremely High Mission/Battle and Engagement Expectations

- A battlefield 20 years in the future that is different from any that has ever existed
- A synergistic system; the utility of any one component is a function of the utility of all other components
- Highly human dependent; the most complex component on the battlefield



No One Has Succeeded So Far



A Balanced and Judiciously Executed Modeling and Simulation Program Can Maximize System Utility And Minimize Risk

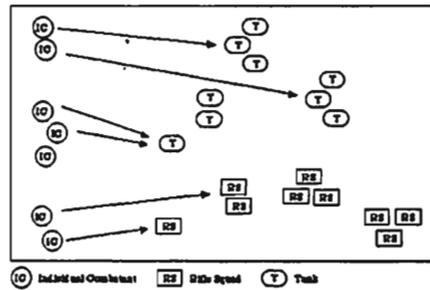
- Facilitate early and continuous common understanding of objective system expectations by developer and user
- Enable detailed visualization of technical contributions to circa 2006-2016 battlefield
- Support exploration of technical approaches within their systemic context
- Enable simultaneous consideration of the engineering, engagement, and mission/battle aspects of the system

It's the best means for knowing where you are going and what to expect when you get there

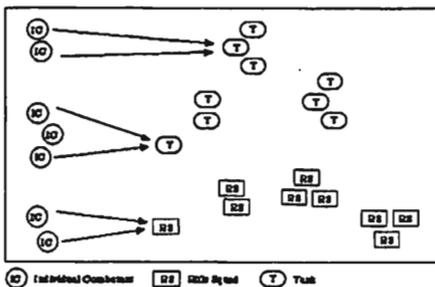
Illustrative SUO Modeling and Simulation Application (DSB Concept Exploration)

- ISSUE:
 - What is the optimal mix and application of technologies to optimize a small team's employment of remote fires to destroy the enemy? (NOT what is the best way to submit the existing request for fire!)
- SIMULATION::
 - Virtual Concept Exploration Facility
 - Men-in-the-loop: USMC lieutenants and Army captains
 - Environment: 2016

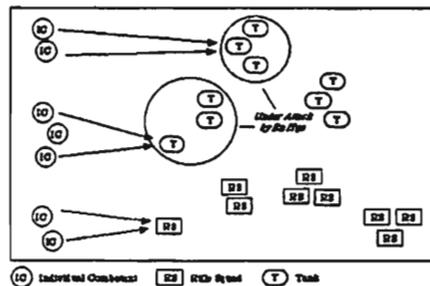
Initial Case: Every Soldier an FO



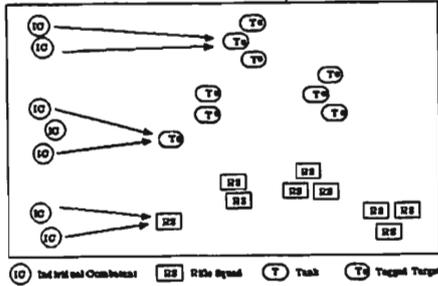
Finding 1: Multiple Redundant Intra-team Engagements



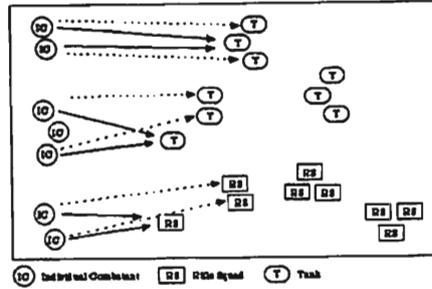
Finding 2: Multiple Redundant Intra-battalion Engagements



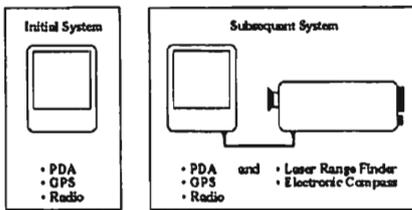
Finding 3: Considerable Time Was Wasted Adjusting Fires



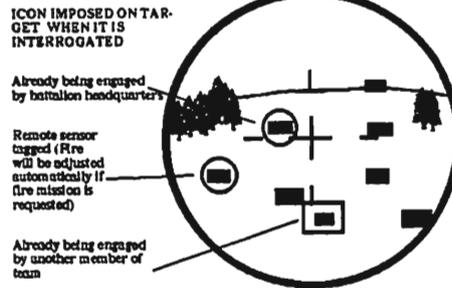
Finding 4: Engagement of Subsequent Targets Was Slow (Sequential)



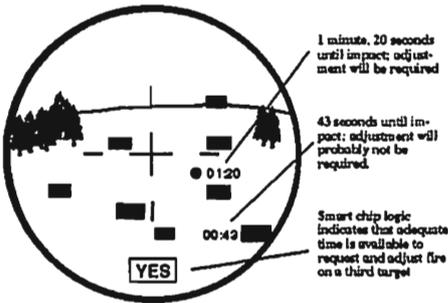
Finding 5: The Incorporation Of A Mello-type Device Enhances Precision, But The Combination Is Ungainly



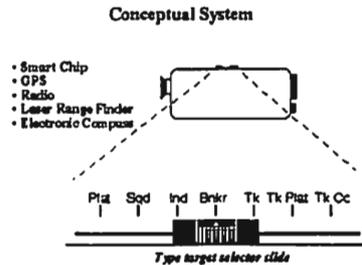
Technical Requirement 1: Develop means to reduce multiple engagements of same target



Technical Requirement 2: Develop means to facilitate management of multiple requests



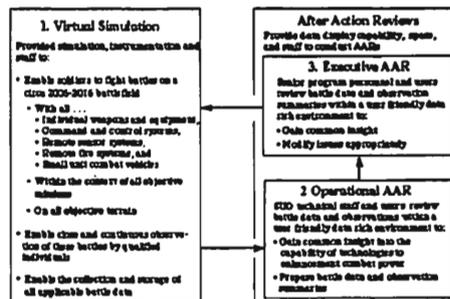
Technical Requirement 3: Integrate PDA/Mellos Functions Into Single Device



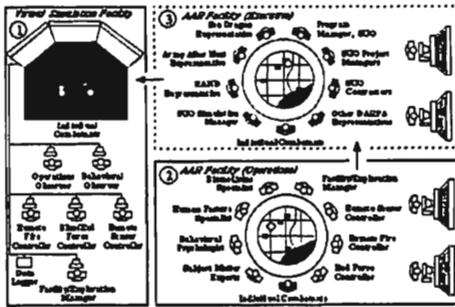
Possible SUO Implications of DSB Findings

- The key to optimizing the employment of remote fires by small units may be the technological enhancement of 2-man elements rather than each individual combatant
- There may be a higher payoff from providing technological enhancements for the management of multiple simultaneous requests for fire by an individual (or 2-man element) than enhancing the submission of individual requests
- Increasing the number of requesters increases the potential for simultaneous engagements of the same target and means must be found to minimize this.

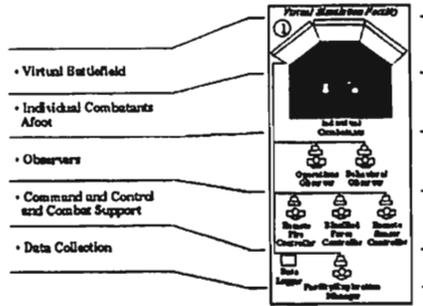
How This Insight Was Gained



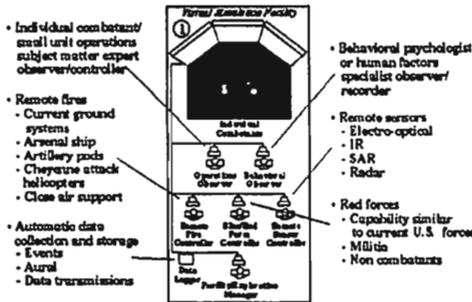
Physical Entities of a Small Unit Virtual Concept Exploration Facility (ver 2.0)



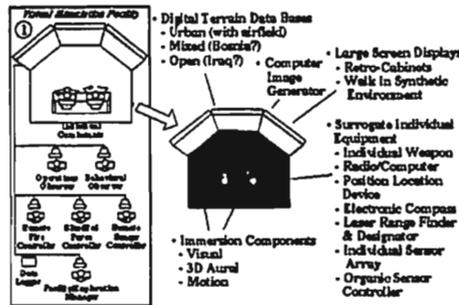
The Virtual Simulation Facility



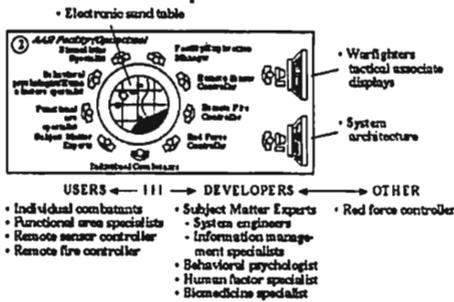
Creating the Circa 2006-2016 Battlefield



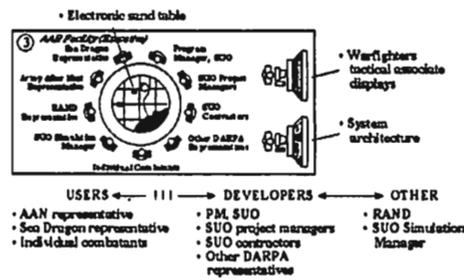
Immersing the Individual Combatant Afoot Into The Circa 2006-2016 Battlefield



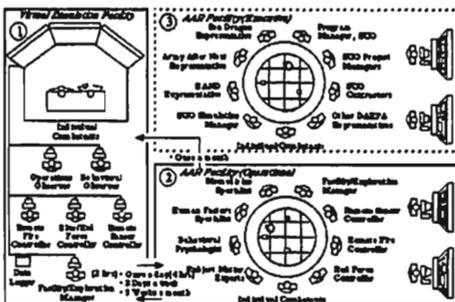
The AAR: Gaining Common Insight At The Operational Level



The AAR: Gaining Common Insight At The Senior Level



It's a Collective Process!!!



SUO Modeling and Simulation Issues

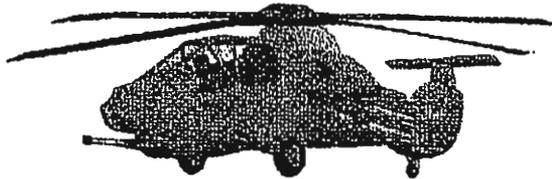
SUO Functionality	1. What is the best technical approach for generating the most realistic virtual environment?	2. What is the best technical approach for providing the individual awareness with the greatest tactical utility?	3. What is the best technical approach for providing a tactical planning and testing capability with the greatest tactical utility?
Structural Awareness	•	•	•
Tracking	•	•	•
Fire Support/Target Designation	•	•	•
Planning	•	•	•
Coordination	•	•	•
Tactical Training	•	•	•
Simulation Management	•	•	•
Communication	•	•	•

SUO Modeling and Simulation Issues

SUO Functionality	4. What is the best technical approach for abstracting the weight and maximizing the user friendliness and utility of the decentralized components of the system?	5. What is the best technical approach for displaying "map", structural elements, topology, status, and message data in a transparent, user friendly, and efficient manner for the individual components?
Directional Awareness		●
Tracking		●
Fire Support Participation	●	●
Planning		●
Coordination	●	●
Tactical Briefing	●	●
Resource Management		●
Communications	●	

AIR CAVALRY REGIMENT

- **Mission:** cover deployment of AAN
- **Regimental C³** from long-dwell aircraft
- **3 squadrons** of three troops each
 - Each squadron has FARRP
 - Double manning throughout
- **Troop** has 4 RAH-66 Comanche, 4 Scouter vehicles, 1 utility helicopter
- **Strengths (~) Troop 40, Squadron 140, Regiment 500**



**RAH-66
Comanche**

- **Light attack helicopter, IOC ~ 2010**
- **20 times more survivable**
- **5 times better RSTA, P_k, OR rate**

Sit Map

AAN Map

Stack 30

AIRBORNE INFANTRY BRIGADE

- **Mission: establish and protect APOD**
- **Brigade C³ from long-dwell aircraft**
- **4 battalions of four companies each**
 - **Each company has 8 TeamCars**
 - **Double manning throughout**
 - **One utility helo per company**
- **Teams normally assigned immediate fire LIFR units; battalion others as GS**
- **Strength: company 96, battalion 400, brigade 1600**

Sit Map

Infantry AN

AAN Map

MECHANIZED INFANTRY BRIGADE

- **Mission:** control urban areas
- **Brigade C³** from long-dwell aircraft
- **4 battalions of four companies each**
 - Per Co, 6 SquadPod, 2 EDFs
 - Double manning throughout
- **Cos normally assigned immediate fire LIFR units; battalion others as GS**
- **Strength: company 96, battalion 400, brigade 1600**

1/2

AIRMOBILE INFANTRY BRIGADE

- **Mission:** control urban areas
- **Brigade C³** from long-dwell aircraft
- **4 battalions of four companies each**
- **Cos normally assigned immediate fire LIFR units; battalion others as GS**
- **Strength: company 70, battalion 210 ; 2 Utility Helo Cos @ 120; Squadron EDFs @ 120; brigade ~ 1100**

2/2

Sit Map

AAN Map