INSTITUTE FOR SIMULATION AND TRAINING

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PM TRADE
DARPA

August 7-8, 1990

Summary Report

The Third Workshop on Standards for the Interoperability of Defense Simulations

Volume III: *View-Graphs from Working Groups Presentations*

IST

Institute for Simulation and Training
12424 Research Parkway, Suite 300
Orlando FL 32826

University of Central Florida
Division of Sponsored Research

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report presents a summary of the activities of The Third Workshop on Standards for the Interoperability of Defense Simulations sponsored by DARPA and PM TRADE, and hosted by IST/UCF on August 7-8, 1990.

The primary goal of this workshop was to recommend revisions to the proposed Draft Standard for Protocol Data Units in Distributed Interactive Simulation (DIS) published in June 1990 by IST.

This volume contains the view-graphs used in presentations made in the individual working groups.

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Summary Report

The Third Workshop on Standards for the Interoperability of Defense Simulations

Volume III: *View-Graphs from Working Groups Presentations*

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12424 Research Parkway, Suite 300
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IST-CR-90-13

PREFACE

Purpose

The purpose of this report is to present the minutes from the Third Workshop on Standards for the Interoperability of Defense Simulations. This workshop took place in Orlando, Florida on August 7-8, 1990 and was hosted by the Institute for Simulation and Training (IST), a part of the Division of Sponsored Research for the University of Central Florida (UCF).

This continuing work on standards is sponsored by the Defense Advanced Research Projects Agency (DARPA) and is administered by the Army Project Manager for Training Devices (PM TRADE).

Background

This is the third workshop concerning the development of technical standards for networking defense simulations. These standards are intended to meet the needs of large scale simulated engagement systems which are being used increasingly to support system acquisition, test and evaluation, tactical warfare simulation and training in DoD. The primary goal of this workshop was to recommend revisions to the proposed **Draft Standard for Protocol Data Units in Distributed Interactive Simulation** (DIS) published in June 1990 by IST. Another goal of the workshop was to continue work towards developing standards in other areas of Distributed Simulation.

Workshop Summary

The two day workshop focused on three major topic areas. These are: Communication Protocols, Terrain Databases, and a new area called Performance Measures.

Discussions in the Communication Protocols Working Group were led by Joe Brann, IBM and Mike McGaugh, McDonnell Douglas. This group concerned itself with resolving issues related to the Draft Standard. Recommendations were made for incorporation in the revised draft standard which will be published in January 1991. One subgroup, the Communications Architecture Subgroup, met separately. This group focused on issues related to communications architecture. In particular, this group sought to more clearly define the services that a DIS requires from the communication architecture supporting the DIS application. This group was led by Steve Blumenthal, BBN and Al Kerecman, USACECOM.

Discussion in the Terrain Database Working Group was led by Mr. Dexter Fletcher, IDA. This group continued its work with representation and interpretation of terrain data.

A new working group, the Performance Measures Working Group, met to discuss human and equipment performance measures. This working group was led by Dr. Bruce McDonald, IST. This group focused on operator and equipment performance measures as well as required level of fidelity.

This report has been issued in three volumes. Volume I contains the minutes for the plenary session and a list of attendees. Volume II contains the view-graphs from the plenary sessions. Volume III contains the view-graphs used in presentations made in the individual working groups.

CONTENTS - VOLUME III: View-Graphs from Working Group Presentations

List Of Issues To Be Discussed By The Individual Working Groups

0091-1181

SUMMARY OF ISSUES FOR DISCUSSION BY THE INTERFACE & TIME/MISSION CRITICAL SUBGROUPS

The following is a list of questions and issues resulting from the release of the current draft standard. Addressing these issues is vital to formulating a final draft by January.

1. **Orientation**

   a. Should Euler angles or Quaternions be used to transmit orientation of an entity?

   b. Confirm recommendation that angular measure be in BAMS:
      - Unsigned integers
      - 32 bit BAM
      - 16 bit BAM for articulated parts

2. **Dead reckoning**

   a. How should various dead reckoning algorithms be specified? (should a field for enumeration values be used, should entities be classified according to the algorithm used, etc.)

   b. Should specific algorithms be required for dead reckoning or should each simulator be free to use its own algorithm (correlation concerns)?

   c. Should default update rate thresholds be established in the ACTIVATE PDU?

3. **Articulated Parts**

   a. Should articulated parts be dead reckoned? If so, which ones? What kind of dead reckoning algorithm should be used?

   b. How many degrees of freedom are required?

   c. Develop a method for specifying articulated parts.
      - Interim solution
      - Long term solution
      - Sub-articulated parts

4. **Data Representation**

   a. How should entity rotation rates be scaled to accommodate present and future needs (currently a 32 bit signed integer is specified in BAMs per sec. It is argued that this provides, at most 1/2 rotations per sec)?

   b. What resolution should be used for world coordinates? Is

1/32 m sufficient (this is a subgroup recommendation; the standard specifies cm)? What resolution is sufficient for:
- Engineering systems
- Geosynchronous orbits

c. Should muzzle flashes be represented using information in the FIRE PDU?

d. How much information about a platform should be included in the appearance PDU and how much should be considered "common knowledge"?

e. Should alignment of data types be specified?

f. Is there a need to provide for alternate character sets (currently only ASCII characters are supported)?

g. Should byte (bit) ordering be specified (or mentioned at all)?

h. A change in the definition of the 32 bit Entity Type fields is recommended:
Classification - 4 bits (0-3)
Domain - 4 bits (4-7)
This change is recommended to make it more readable in hexadecimal. Should this change be implemented?

5. **Fixed or Floating Point**

Should the use of floating point numbers be allowed? If so where is it appropriate?

6. **Dynamic Thresholds**

Specifications concerning the use of the UPDATE REQUEST/RESPONSE PDUs need to be established.

a. Who can send a request?

b. How are multiple requests handled?
- Are requests queued?
- Tighter thresholds override looser?

c. How are limitations placed on the request?

d. Should a request time-out and/or should there be a means to cancel a request?

e. Should linear thresholds be expressed as a fixed length or a percentage of the size of an entity?

f. When and how are default thresholds set?

7. **Weapons and Combat Damage**

a. Should entities that have been affected by a detonation be specified in the DETONATION PDU? If the entity is specified, should the location of the detonation be expressed in the entity coordinates of the affected entity?

b. How much information concerning the detonation is needed in the DETONATION PDU? (should it be assumed that entities are aware of the force of certain munitions or should the force be specified?)

c. Develop definitions for DIRECT and INDIRECT fire.

d. Should the range field in the FIRE PDU be represented in meters or in the units of the world coordinate system?

e. How are sky-shots to be represented? Should the DETONATION PDU include a "result" field so the simulator knows when to stop modeling the trajectory of a round?

f. How are bursts of machine gun fire to be represented? How are tracers to be represented?

8. **Electronic Interactions**

a. How much emitter information should be contained within the simulator and how much should be communicated in the PDUs?

b. A description of what kind of information is required to be contained in an Emitter PDU is needed (this would also imply the types of information that is required to be in the database). What will serve as an interim solution (A RADAR PDU is recommended)? What would the future Emitter PDU look like?

9. **Bit-encoded Attributes**

Should bit-encoded attributes be used in the Standard? Should character strings be used as an alternative?

10. **Query Protocol**

Should Query PDUs be added to the draft standard? Should they be part of a future, addition to the current draft?

11. **Timestamps**

Confirm recommendation that timestamps should be 32 bit unsigned integers, LSB representing whether the timestamp is absolute or relative.

12. Entity Activation

a. How are missile entities activated/deactivated?

b. How are cultural features activated/deactivated or modified?

c. Should entities be further classified as STATIC and DYNAMIC to differentiate the activation process required to introduce them to the simulation?

SUMMARY OF ISSUES FOR DISCUSSION BY THE COMMUNICATION ARCHITECTURE SUBGROUP

The following is a list of questions and issues resulting from the release of the current draft standard. Addressing these issues is vital to formulating a final draft by January.

1. **Communication Requirements**

   Communication requirements of the DIS application should be specified (Network management functions should also be specified). Should these requirements be specified in the current standard? If so, how should they be stated?

2. **PDU size**

   What should the maximum PDU size be?

3. **Site, Host, Identification**

   How are Identification numbers to be assigned? Are they permanently assigned or assigned at the start of each exercise? Who assigns the numbers?

4. **TADIL-J/JTIDS/Link-16**

   Should these models be adhered to? How do these models affect the current standard? Future standard work?

5. **Network Traffic**

   What kinds of recommendation can be made to reduce the number of messages that need to be issued to accomplish the goals of DIS?

6. **Priority and Security**

   Fields representing the priority and security level of a PDU are going to be added to the PDU header. Does the communications architecture group have any recommendations concerning how this should be accomplished?

SUMMARY OF ISSUES FOR DISCUSSION BY THE
PERFORMANCE MEASURES WORKING GROUP

The following is a list of questions and issues resulting from the release of the current draft standard. Addressing these issues is vital to formulating a final draft by January.

1. **Entity & Event Identifiers**

    a. When should Event Identifiers be used?

    b. How should Entity Identifiers be assigned? Who assigns them? Are they permanent or valid only for the duration of the current exercise?

    c. What types of munitions should be assigned identification numbers? How should this be accomplished?

2. **Logistics Support**

    a. How are simulated repairs to be represented? How specific do the repairs need to be?

    b. What functions should be defined for resupply? (partial resupply, messages required, etc.)

    c. Should DI be included in resupply?

3. **Environmentals**

    Training and equipment evaluation objectives should be further defined in order to specify sizes, densities, etc. to meet those objectives.

4. **Appearance Information**

    a. What kind of information is required to adequately describe the appearance of:
        - Aircraft
        - Navy ships
        - Dismounted Infantry

    b. How should amphibious vehicles be classified?

    c. How much resolution is needed for articulated parts?

5. **Country Information**

    How should countries be specified? Should each country in the world be included? How should factions within a country be specified?

QUESTIONS FOR PERFORMANCE MEASURES GROUP

OPERATOR PERFORMANCE MEASURES

What does an instructor or evaluator need to know to evaluate operator/team performance at the end of the exercise?

What does an instructor or evaluator need to know to properly run an exercise?

What commands do instructors or evaluators need to set up and run an exercise?

EQUIPMENT PERFORMANCE MEASURES

What does an evaluator need to know to evaluate equipment performance at the end of the exercise?

What does an evaluator need to know to properly run an exercise?

What commands do evaluators need to set up and run an exercise?

FIDELITY MEASURES

What should dismounted infantry, Green Berets, SEALS look like?

What do you do when the resolution of the simulator display will not allow a target to be identified and engaged in the simulator at the same range as in the real world?

Articulated parts:

- Which articulated parts and other appearances have training or equipment evaluation value and require representation?
  - Aircraft
    - Fighter
    - Attack
    - Bomber
    - Reconnaissance
    - Tanker
    - Miscellaneous

Ship

- Carrier
- Battleship
- Cruiser
- Destroyer
- Frigate
- Patrol
- Submarine
- Amphibious Assault
- Support
- Miscellaneous

Land Vehicles

- Tank
- APC
- Support
- Artillery
- Miscellaneous

How far should the above articulated parts move before a new appearance PDU is issued?

Would dead reckoning work for articulated parts? Which ones?

What unclassified submarine sounds are important in ASW?

How do we communicate classified sounds?

Should the Emitter PDU be issued less often since electronic sensors do not represent the position of platforms as accurately as direct vision?

Is the representation of tracers important?

Should missiles be depicted visually in flight?
- Subsonic missiles
- Mach 1
- Mach 2
- Mach 2+

Should ballistic weapons be depicted visually in flight?

What additional indications should be depicted for a TOW or Dragon launch?

How do we coordinate the depiction of a rotating antenna between simulators?

SUMMARY OF ISSUES FOR DISCUSSION BY THE TERRAIN DATABASES WORKING GROUP

The following is a list of issues presented in position papers submitted as a result of the Second Conference on Standards for the Interoperability of Defense Simulations. Addressing these issues is vital to developing a draft standard for Distributed Interactive Simulation.

1. **What kind of database information should be a requirement for DIS?**
   - Terrain
   - Emitter
   - Information concerning entities

   (what lacks in the database needs to be communicated in the PDUs)

2. **Terrain Databases**

   a. How are Terrain Database identifiers assigned? Who assigns them?

   b. Should information concerning dynamic terrain (cultural feature entities) be included in the terrain data base information?

3. **Oceanographic Information**

   How is oceanographic information to be represented?

4. **Dynamic Terrain**

   Develop a PDU to communicate changes in the terrain.

Slides From The Individual Working Groups

Terrain Databases Working Group

Mr. Dexter Fletcher
(for Mr. George Lukes)
Chairman

00511177

STATUS: Distributed Simulation Database Interchange

Eric Lang
Steve Smyth

BBN Advanced Simulation Division

- **Conceptual Model (Smyth)**

  The basis for describing a view of the simulated environment.

  The elements adopted in SDIS.

- **Product Status (Lang)**

  SIMNET database conversion to SDIS.

  Supporting software.

  User comments.

Database Interchange Progress
In Work

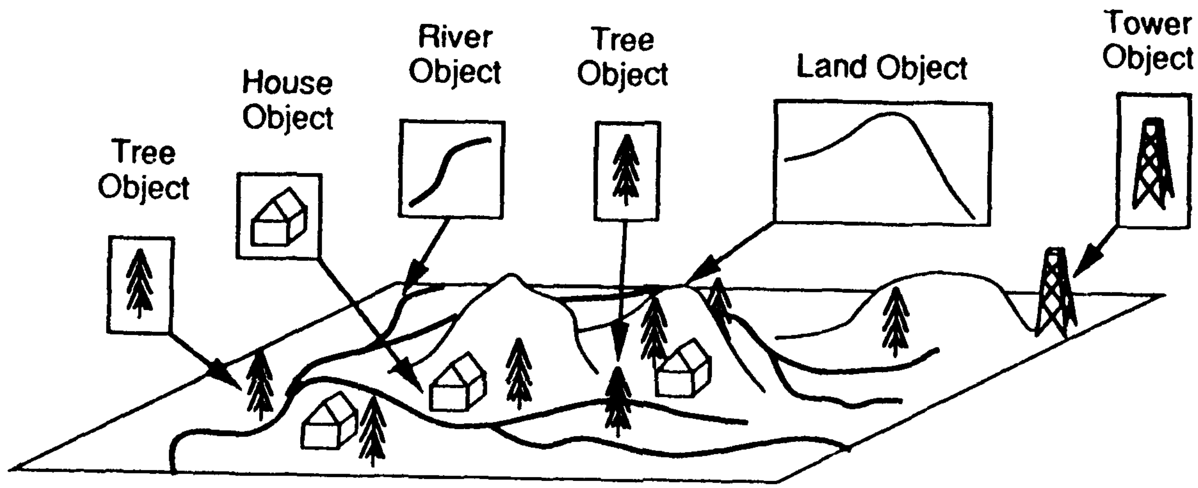
- 50 Km Hunter-Liggett available in July
  - Objects Packaged with Geometry & Topology; Packages Sized for Efficient Processing

- Object-Oriented Application Program Interface (API) Library
  - Routines Get/Put Objects and their Geometry & Attributes
  - Direct Encoding/Decoding Increase Speed and Reduce Memory Needs

- Example Viewing Application Program

- Documentation
  - Definition of Simulation Object Representation
  - Database Interchange Specification
  - Programmer's Manual for the API

Approach: Object Based Representation



Characteristics:
- Natural Object Based
- Flexible Attributes and Geometry

Advantages:
- Incremental Updates and Transfer
- Easy to Modify or Extend

Disadvantages:
- Complex Structure
- Support Tools Necessary

SDIS Status

<u>Last Meeting:</u>
- 8Km SDIS Version 1.2 Dataset
- SDIS Version 3.0 User's Guide

<u>Now:</u>
- 8Km SDIS Version 3.0 Dataset
- 50Km SDIS Version 3.0 Dataset
- SDIS Application Programmer's Interface
- SDIS Application Shell
- SDIS Iris View
- SDIS Version 3.0 User's Guide

SDIS 50Km Dataset

- Hunter-Liggett Area
- 381 SDIS Packages
- 67 MB uncompressed
- 30 MB compressed

SDIS 50Km Dataset Packages

File Name	Description	File Type
pkg_0	file index	DbDescriptionPackage
pkg_1	class index	DbDescriptionPackage
pkg_2	database attributes	DbDescriptionPackage
pkg_3	terrain	ObjectPackage
...	...	...
pkg_51	terrain	ObjectPackage
pkg_52	terrain textures	ImagePackage
...	...	...
pkg_61	terrain textures	ImagePackage
pkg_62	tree lines	ObjectPackage
...	...	...
pkg_68	tree lines	ObjectPackage
pkg_69	tree line texture	ImagePackage
pkg_70	forests	ObjectPackage
...	...	...
pkg_205	forests	ObjectPackage
pkg_206	forest textures	ImagePackage
...	...	...
pkg_209	forest textures	ImagePackage
pkg_210	models & instances	ObjectPackage
...	...	...
pkg_337	models & instances	ObjectPackage
pkg_338	model textures	ImagePackage
...	...	...
pkg_380	model textures	ImagePackage
sdis_def	SDIS Definition	Text file
o_class	object classes	Text file
a_class	attribute classes	Text file
A README	additional information	Text file

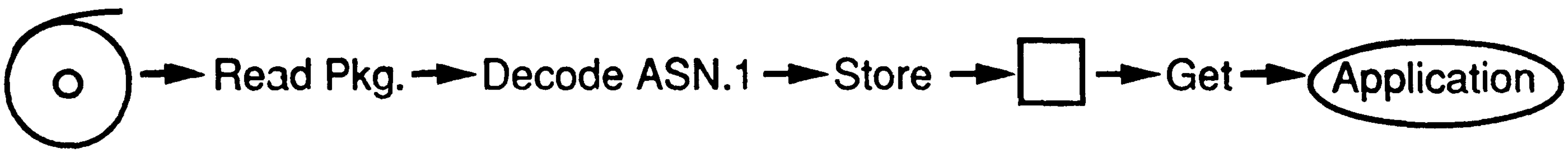
SDIS Application Programmer's Interface

<u>Goal:</u> To provide an object based program interface to SDIS Datasets.

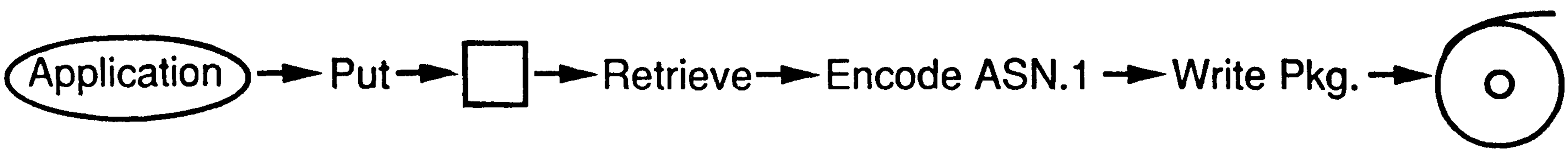
- Read SDIS Dataset Packages
- Write SDIS Dataset Packages

SDIS Application Programmer's Interface

Read Packages



WritePackages



Lang - BBN - 5

SDIS Application Shell

Example application that uses SDIS API routines to completely traverse an SDIS Dataset.

Simple retrieval of object data:

```
while(sdis_getnext_asn_package())
{
  while(sdis_getnext_object())
  {
    /* get data for objects... */
  }
}
```

SDIS Iris View

Example application based on SDIS Shell to completely traverse an SDIS Dataset and graphically display the data on an Iris Workstation.

SDIS Version 3.0 User's Guide

1 SIMNET Database Interchange Specification
- 1.1 Physical Representation
- 1.2 SDIS Structures
- 1.3 Multi-Component Example

2 Class Definitions
- 2.1 Attribute Classes
- 2.2 Object Classes

3 Application Programmer's Interface
- 3.1 Data Structures
- 3.2 Function Reference
- 3.3 API Example

SDIS Dataset User Comments

<u>Comment:</u> Use of 2-simplexes creates too many polygons for visual systems.

<u>Solution:</u> Extend API to join coplanar 2-simplexes with similar attributes into n-sided polyons.

<u>Comment:</u> Include surface/vertex normals.

<u>Solution:</u> Add normal calculation to API.

<u>Comment:</u> Interior polygons useless to some systems.

<u>Solution:</u> Add application specific attributes to simplexes.

SDIS Dataset User Comments

Comment: Difficult to resolve colors on intersecting coplanar polygons.

Solution: Add application specific attributes to simplexes.

Comment: Difficult to resolve color on textured polygons for systems that cannot process textures.

Solution: Add alternate colors to textured simplexes.

Comment: Index packages hard to modify.

Solution: Improve API package editing routines.

SDIS Dataset User Comments

Comment: Documentation lacking.

Solution: SDIS Version 3.0 User's Guide.

Comment: Decoding ASN.1 difficult on PC.

Solution: Port SDIS API to PC environment.

Comment: Don't know what's in dataset and what it looks like.

Solution: Provide SDIS Dataset Dictionary with Datasets.

SDIS Availability

Contact George Lukes (ETL) for copies of:

- 8Km SDIS V3.0 Dataset
- 50Km SDIS V3.0 Dataset
- SDIS Application Programmer's Interface
- SDIS Application Shell
- SDIS Version 3.0 Users's Guide

What is a Reference Data Model?

Formal description of

- primitive data elements,
- their properties,
- relationships between elements, and
- operations that create, destroy, combine, and change elements.

What is a Reference Data Model?

Basis for

- the design and implementation of data representations,
- algorithm design and analysis,
- languages to express structure and operations, and
- data communications protocols to transport data.

The World as Objects

- Real-world entities are represented as discrete objects.
- Structure and behavior are encapsulated.
- Semantic structure is represented as DAG.
- An entity may be part of several objects.

The golf Model

- geometry: physical form
- orientation: rotational relationship of form to space
- location: translational relationship of form to space
- frame: the spatial context of the form

Base Representation

- terminal nodes in semantic network (DAG)
- highest level of detail
- specialized (Leopard 2)
- concrete (3D)
- detailed (1cm resolution)
- components (wheel)
- disaggregated (tree)

Semantic Networks

- links between objects that indicate the direction and nature of base - non-base object relationships

- level of detail: coarse->fine

- abstraction: abstract->concrete

- generalization: general->specific

- composition: whole->part

- aggregation: singleton->group

Higher-Level Representations

- origin or interior nodes in semantic network (DAG)
- reduced level of detail
- generalized (vehicle)
- abstract (center of mass)
- crude (looks ok from afar)
- composite (helicopter)
- aggregated (forest)

Geometry

- physical form
- simplex primitives
  (point, straight line
  segment or arc, triangle,
  tetrahedron)
- generators for non-planar
  and procedurally-defined
  forms
- Boolean composition

Smyth-09

Orientation

- rotational relationship between object's own internal reference frame and the space in which it is embedded
- can be unknown or indeterminate

Smyth-10

Location

- Points (0-simplices) and locations are not the same.
- Location is an attribute of a point.
- Location may be uncertain or unknown.
- Location may be specified in many ways: Cartesian coordinates, polar coordinates, parametric coordinates, or a locus of points, for example.

Frame of Reference

- spatial context for orientation, location, and other spatial relationships
- organized in graphs, usually a DAG or tree
- only forms with connected frames have spatial relationships,
- frame may be free: "imagine a table..."
- frame may be of maximum scope

Smyth-12

Geometric Classes

- Prototypes define geometry that can be inherited by an unlimted number of instances.

- Prototypes have a "null" reference frame, the "free frame."

- The binding of a prototype with a frame produces an instance.

- Materialization copies geometry inherited by an instance from a prototype and creates a new first class object.

Smyth-13

Time

- time-dependent attributes: "effective time" (`last week they took down the fence and dug a ditch in its place').
- state of knowledge changes with time: "valid time" or "data time" (`last week we found out that that linear feature in the aerial photograph was really a ditch, not a fence as we previously thought')

Versioning

- attribute uncertainty (`is that fence 1m high or 10m?')

- object class uncertainty (`is that linear feature a fence or a ditch?')

- many times alternate plausible versions of reality must coexist in a computer representation

- data quality and lineage attributes may be used to determine the reliability or usability of a particular "thread of reality."

Thread of Reality

- The base representation always represents a possible configuration for the modeled environment.

- A connected path through objects such that no two of the objects is connected by a path in the semantic network and for which there is a path to every object in the base representation also represents a possible configuration of the modeled environment (a "thread of reality") .

Related Issues

- computing implicit spatial relations
- spatial indexing
- representation of raster and vector data
- encoding the **golf** model

Summary

- geometry
- orientation
- location
- frame

- golf supports a rich model of an objectized world

- multiple simultaneous representations

- adjustable granularity of representation

- base representation has been implemented for real applications

Smyth-19

ITD Decoding System

Stephen Ford

Digital Mapping Laboratory
School of Computer Science
Carnegie Mellon University

6 August 1990

Digital Mapping Laboratory - MAPS

Research areas include feature extraction, scene analysis and spatial database systems for digital mapping applications

MAPS members:

Research Leader

Dave McKeown

Research Staff and Programmers

Wilson Harvey
Matt Diamond
Federic Perlant
Jean-Christophe Dhellemmes
Jeff Shufelt
Emily Burke
Michael Polis
Stephen Ford
Felice Goldgraben

ITD Decoding System

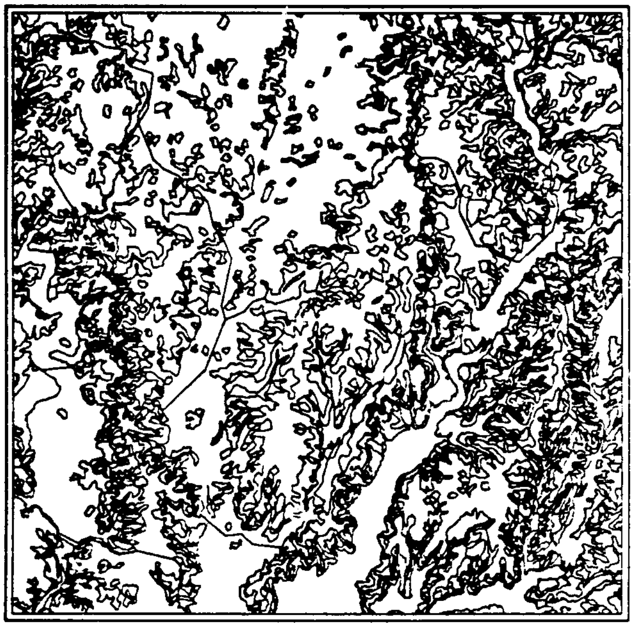
Series of Programs and Shell Scripts to Decode ITD Files

- Outputs ITD Thematic Files to Text Files

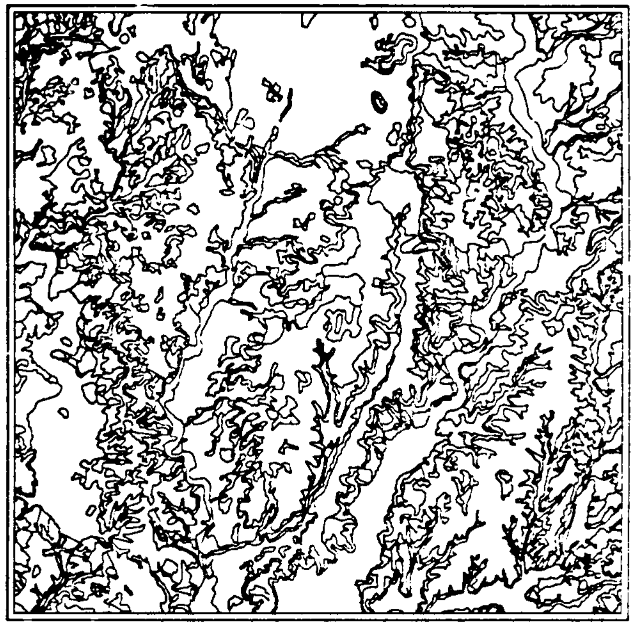
```
FeaId: 2
FeaType: L
Code: 1P0302
Def: Road, loose/unpaved
AttCount: 9
Surface type: loose/unpaved
Theme: transportation
Structure: non-elevated
Weather type: all weather
Travelway: non-divided
Existence: definite
Accuracy: accurate
Slope gradient: 3 %
Width: 55 dm
SegCount: 1
List:     1 F
```

- Runs on DEC or SUN Platform under UNIX Operating System

Fort Hood ITD



SURFACE CONFIGURATION



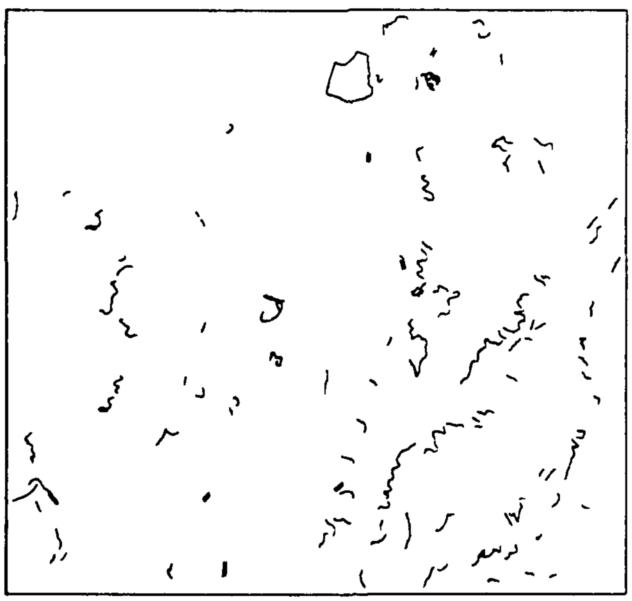
SURFACE MATERIALS

TRANSPORTATION

Fort Hood ITD

VEGETATION

SURFACE DRAINAGE



OBSTACLES

ITD Decoding System

Available for Distribution

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Dynamic Terrain

- Some Thought Experiments -

Michael Moshell
IST's Visual Systems Laboratory
8 August 1990

CONTENTS

VSLB90.13-1

Virtual Reality vs. Tactical Dynamic Terrain

Virtual Reality: the "buzz word" of 1990

- Head Mounted Stereo Displays
- DataGlove™
- Interactive Physical Simulation
- Shared (Networked) Graphical Space

VR Research at IST's Visual Systems Laboratory:

- Head Tracking Display for SIMNET
- Physical Modeling with Constraints
- Object Oriented Modeling & Simulation
- Object Oriented Databases
- *Virtual Reality Testbed*

BUT -

Most of this work is "6.1" style - 5 to 10 year payoff.

Could we build a low cost networked Dynamic Terrain simulator system with 1990 technology?

That is the question we will address today.

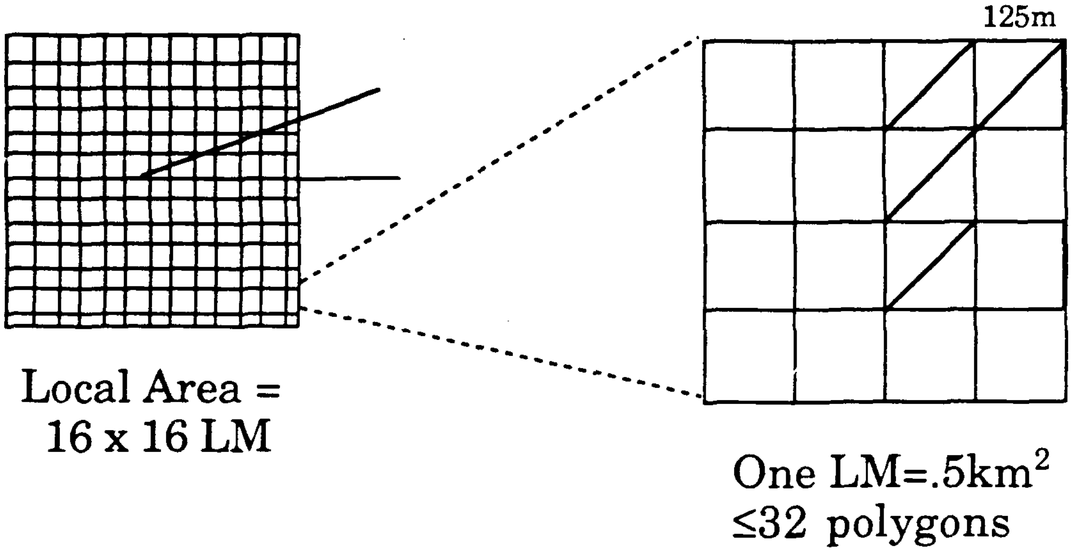
We call this "thought experiment" -

Tactical Dynamic Terrain

VSLB90.13-2

Feasibility of Tactical Dynamic Terrain

- SIMNET I: 300 polys for terrain, 400 culture, 300 models
- 20 degree FOV x 3.5 km =
  8.9 load modules (LM) x (≤32 polys) =
  up to 285 polygons in view.



Let's imagine SIMNET II -

- 600 polys for terrain (300 static, 300 DT)

Now, HOW MANY

- Emplacements
- Craters
- Track marks

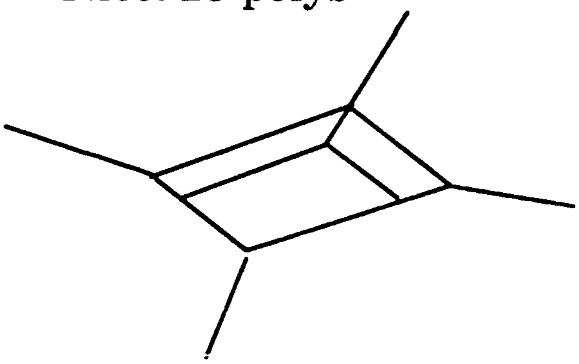
Could we reliably display?

VSLB90.13-3

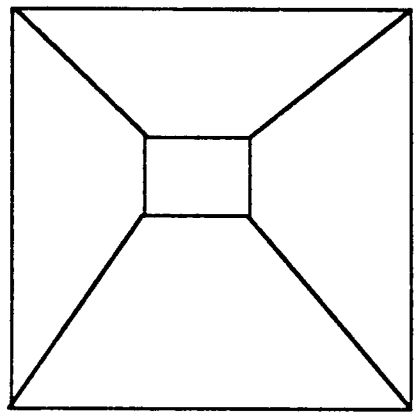
Feasibility of Tactical Dynamic Terrain

Emplacements

- Cheap: 9 polys
- Nice: 25 polys

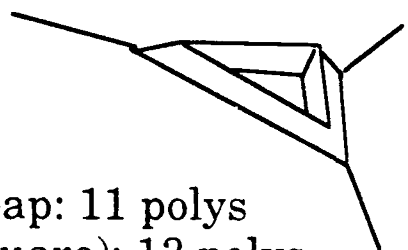


Perspective View

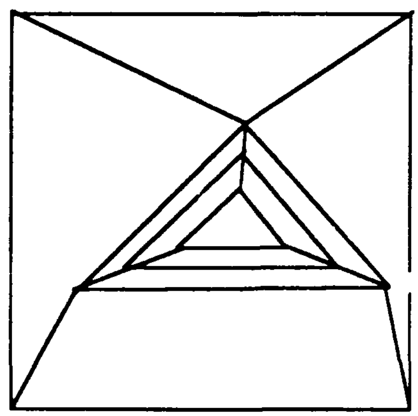


Top View

Craters



- REAL cheap: 11 polys
- Cheap (square): 13 polys
- Nice: 48 polys
  (Irregular hexagon)



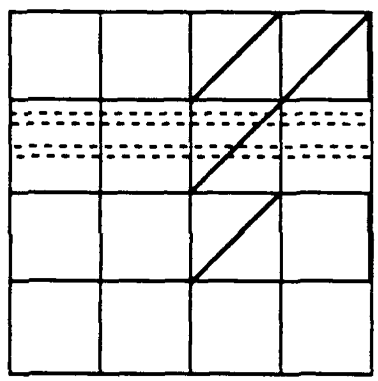
Feasibility of Tactical Dynamic Terrain

Track Marks

Case 1: Straight line travel

= Two polys per flat surface.

Each LM traversed would generate
8 to 24 new polys, for track marks.



Case 2: One maneuver every 5 tank lengths (40m)

= (about) 12-15 maneuvers per 0.5 km (one LM) of which about half would cross poly bounds,

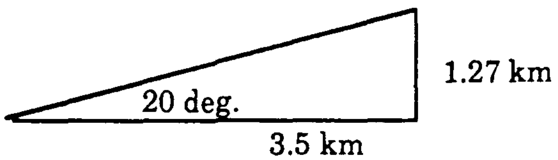
= 18 to 22 (*2) = 36 to 44 polygons per LM traversed.

VSLB90.11-5

Feasibility of Tactical Dynamic Terrain

Maximum Feature Densities with 600 polygons for Terrain (300 for Dynamic Terrain):

	Polys per Feature	Max. Nr. in FOV	Safe Density per KM^2
Emplacement - Cheap	9	33	14
Emplacement - Nice	25	12	5
Crater - Cheap	13	23	10
Crater - Nice	48	6	3
Track Marks - Straight	48/km	6 KM	3
Track Marks - Maneuvering	80/km	4 KM	1.68



Area = 2.23 sq km

And

- If the IG went from 1000 to 2000 polygons and ALL the gain went to Dynamic Terrain,

  - then we'd be using 1000 polygons instead of 300, and so

- These maximum numbers increase by a factor of 3.3 (or you could "pick any three items").

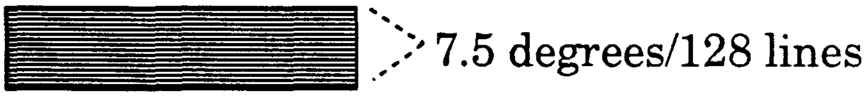
VSLB90.13-6

Feasibility of Tactical Dynamic Terrain

Levels of Detail:

- A 2m high crater (or earth berm) at 1 km range subtends 0.11 degrees.

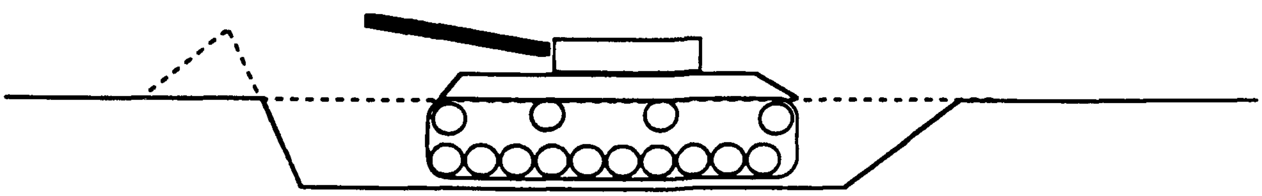
- SIMNET's vertical FOV is about 7.5 degrees, 128 lines - so one pixel is 0.058 degrees high.



- Thus, the 2m berm is two pixels high at 1 KM range.

- If one simply OMITS all DT features at > 1 KM range, this reveals at most 2 pixels of whatever's hiding behind them.

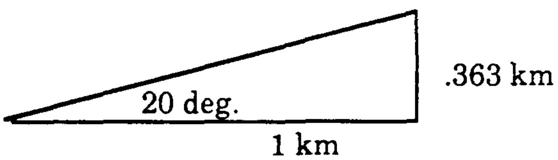
  -- which should be standing in a hole, too... and will automatically be "partially buried" by the depth buffer, in the planar poly in coarse LOD.



Feasibility of Tactical Dynamic Terrain

Maximum Feature Densities with 600 polygons for Terrain (300 for Dynamic Terrain AND 1 km LOD Control):

	Polys per Feature	Max. Nr. in FOV	Safe Density per KM^2
Emplacement - Cheap	9	33	183
Emplacement - Nice	25	12	66
Crater - Cheap	13	23	126
Crater - Nice	48	6	34
Track Marks - Straight	48/km	6 KM	34
Track Marks - Maneuvering	80/km	4 KM	20.6



Area = .18 sq km

And

- You can STILL "pick any three items" if we're using 1000 polygons for DT features.

VSLB90.13-8

Four Dynamic Terrain Features

- Earthworks
  (Emplacements, tank traps, drainage, fords)

  The Need: Hull Defilade!

  The key problems: variable shape, lots of polys

- Craters
  (Bomb and Artillary impact, mines)

  The Need: Improved fidelity

  The key problem: LOTS of craters!

- Track Marks
  (Armor Tread damage to soil & vegetation)

  The Need: Evidence of enemy travel

  The key problem: LOTS of polygons, overlaid.

- Hydrology
  (Rain accumulating in low places, forming streams)

  The Need: Critical effect of precip on trafficability

  The key problem: Updating the whole terrain at once.

VSLB90.13-9

Networking and Database Issues for DT

1) A Scenario

--- *A story incorporating the Four Features* ---

2) Checklist of Features and Activities

--- *What computations, communications?*

3) Database Strategy

- Special (Redundant) DT Database
- Hasty and Careful (Bi-modal) Updating

--- *Show SOMETHING now; get it right later*

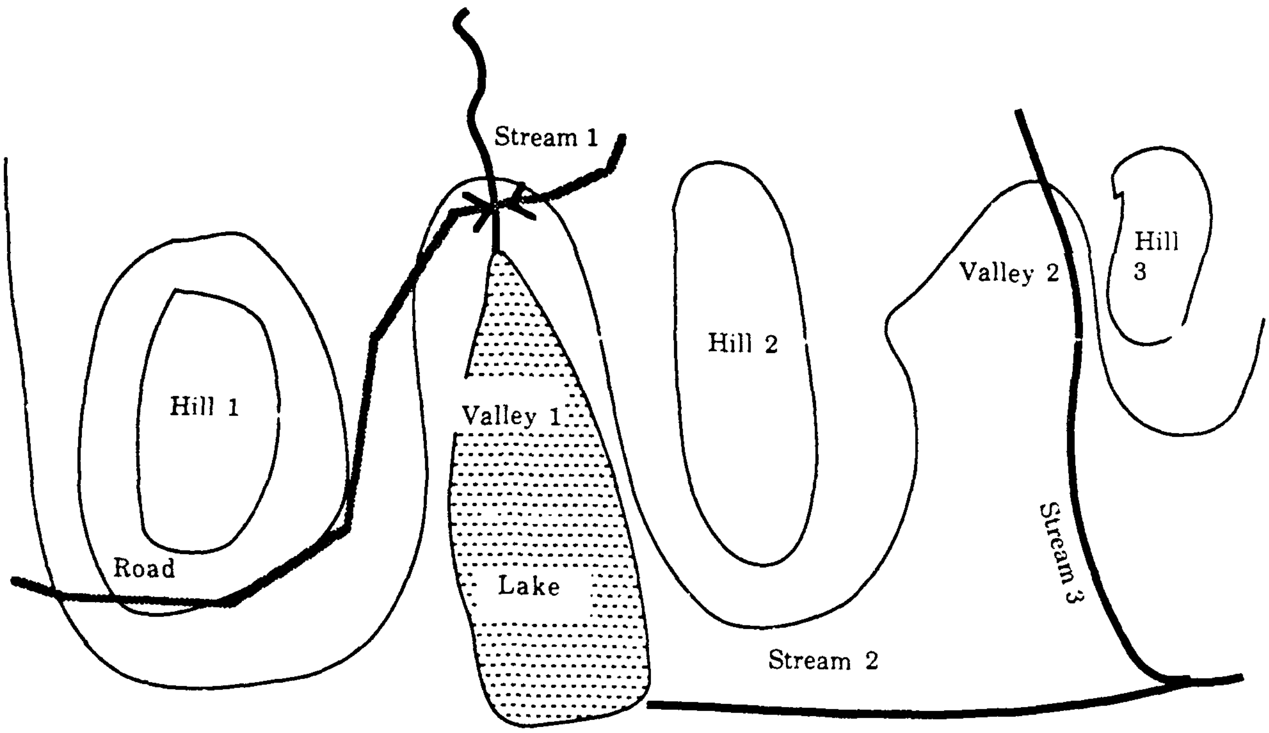
4) Computational Elements

- Engineering Workstation
- DT Processor
- Image Generator/Simulator

5) Communications Protocol

VSLB90.13-10

The TDT Scenario

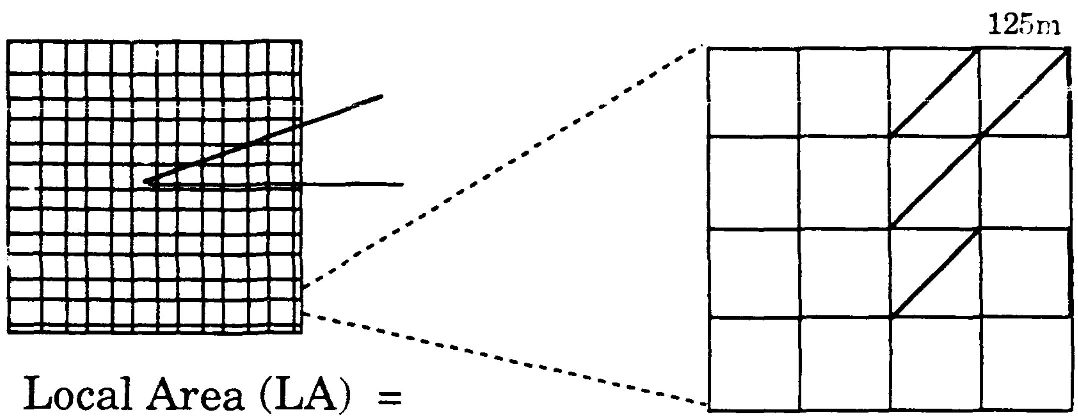


VSLB90.13-11

The TDT Scenario

A Refresher on SIMNET Terminology

Field of View (FOV) = (various); 15 deg x 3 km



Local Area (LA) =
16 x 16 Load Modules

Load Module (LM) =
0.5 x 0.5 km of terrain

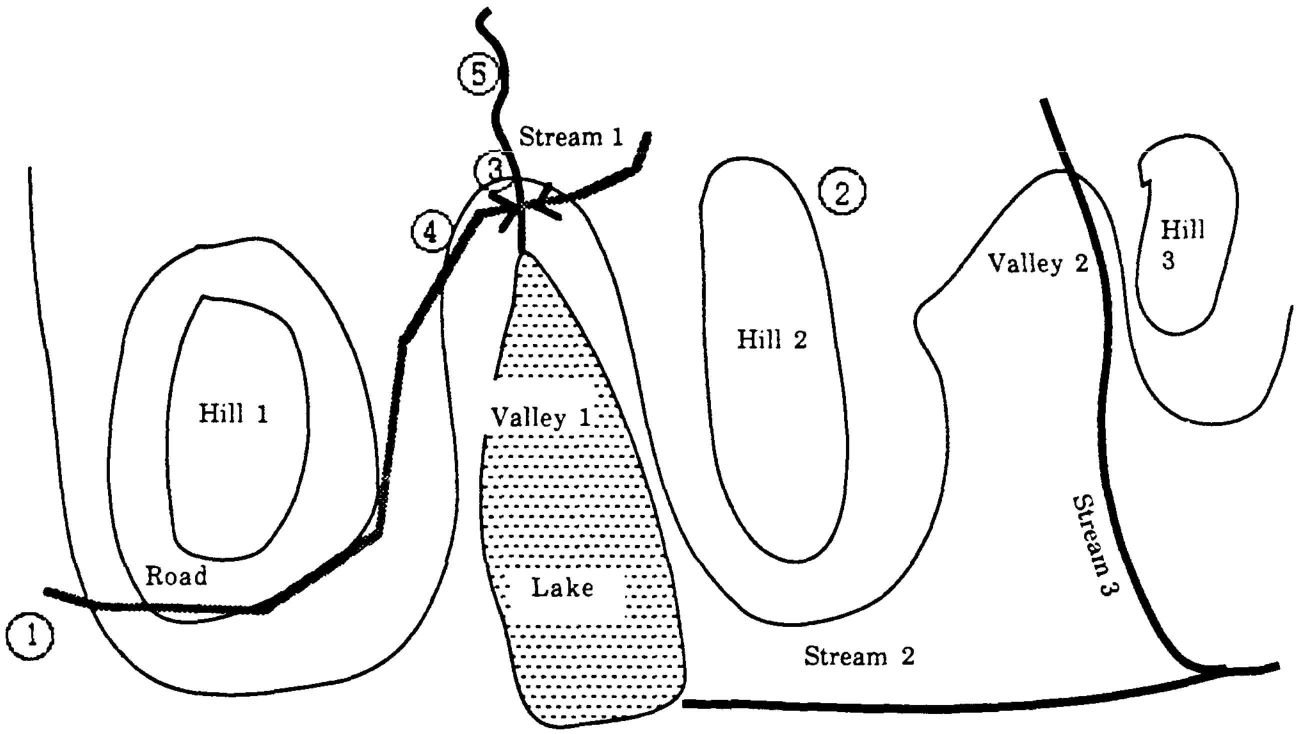
- Local Area Memory (LAM) = RAM memory for storing the Local Area data.
- Platform = weapons carrier (tank, APC, man)
- Entity = simulated active element, usually a Platform

My terminology:

- Local Area Fringe (LAF) = the set of Load Modules around the edge of the Local Area - i.e. "just out of sight" of the central viewpoint.

VSLB90.13-12

The TDT Scenario



A. Blue force moves eastward (1)

B. Red artillary unit (2) bombards bridge (3), craters the road (4); retreats to northeast.

C. Blue bulldozer cuts a ford across the stream (5)

D. Blue unit arrives, cannot cross bridge, uses ford.

E. Rain falls, muddies the scene. Stream, lake rise.

VSLB90.13-13

A Checklist of Features and Activities

Computation:

(1) Red artillary computes impact locations
(2) "Someone" decides bridge is destroyed, reshapes it
(3) "Someone" computes new microterrain for craters
(4) Trafficabilities get updated so tanks can't use bridge
(5) Bulldozer's action simulated while cutting the ford
(6) Rainfall's effects are computed
(7) Track marks are laid down by all parties

Communication:

(1) All simulators must know about all site specific terrain events (craters, digging operations, track marks).

(2) Global effects (rainfall) have to be applied to the whole database.

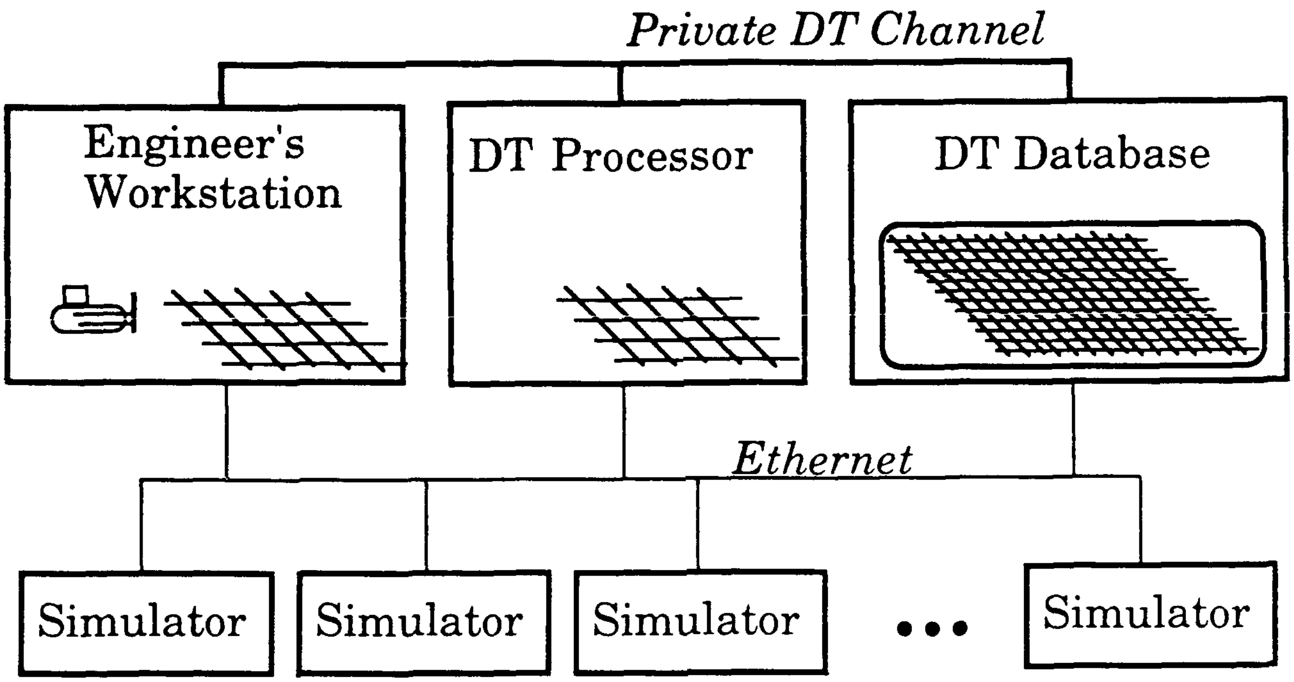
(3) Communication must be timely and must not overload simulation (entity) communications.

Now, let's propose an architecture for doing all this.

VSLB90.13-14

A *Straw Man* Architecture

- New Boxes in the SIMNET Diagram:



- Database Strategy:

A Simulator can need DT information in 2 ways:

(1) "Being there" (LA overlaps the location of action)

(2) "Walking up on it" (LA moves; action is in LA fringe)

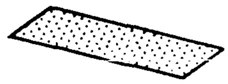
VSLB90.13-15

Database Strategy

(1) "Being There"

- ASAP: simulators show a temporary"flat poly" to indicate action.

  "manhole-cover" for a crater ... 

  "work in progress" polygon for ditch ... 

- DT processor or EWS constructs proper form, installs it in the DT database, announces availability of an updated LM

- Simulator notices it's in LA, requests the new LM.

- DT database broadcasts new LM; all sims copy.

(2) "Walking up on it"

- Simulator notices those LM's in the LAF which are not current, requests them from the DT database.

- DT database broadcasts new LM's; all sims copy.

VSLB90.13-16

Database Strategy

- The Importance of all simulators' copying each upload:

  - All LM's in all Databases are either CURRENT or
    at most ONE UPDATE OLD.

- The magnitude of an update: usually just 1/16 of a LM!

  - Just upload the "dirty quads". Cost?

  Crater (good): 48 polys x 4 vertices x 3 nrs = 576 numbers

  Emplacement (cheap): 9 polys x 4 v x 3 nrs = 108 numbers

- Uploads can be batched or dispersed; not urgent.

  -DT database can "spread the load across time",
    avoiding saturation.

VSLB90.13-17

Computational Elements

- Engineer's Workstation

    - SG Iris 4D70GT (seems to work fine)
    - Spline based interactive earthworks (human operator)
    - Polygon relaxation algorithm
    - update DT database when 'dozer leaves the ditch

- DT Processor

    - Manages the automatic stuff: craters, others' tracks, etc.
    - Watches net traffic, builds appropriate DT structures
    - often (e.g. craters) just invokes templates (additive!)
    - probably has a complete (redundant) DT database

        (why two?)

        - Database machine processes queries;
        - DT processor modifies terrain additively

- The Private Channel

    - High bandwidth (e.g. shared memory, DMA)
    - Possibly not necessary for the 'dozer, because of terrain relaxation prior to transmission.

VSLB90.13-18

Computational Elements

- Image Generators and Simulators
  (The Crux of the Matter, of course)

  - LM Validity Table

    - Keeps track of validity of all LM's
    - motion of the LA => fix any invalid LM's (query)
    - continuous netWatch; pick up others' fixes into DB

  - Temporary flat features in LAM:

    - manhole covers, working 'dozer patches, as
      needed by "reading the mail" on the net.
      - No need to add to ownship DB.

    - tread marks. Add to ownship DB and LAM.

      Meanwhile, being added to DT Database too.
      (BY the DT database processor
      on basis of his dead reckoning model)

      When any simulator picks up a dirty LM, it
      gets the latest tread information.

      Why handle tracks differently? Too many!

  - Double-buffer the <u>whole local database!</u> (2 disk drives)
    Drive A is "read only" (queried by IG, other drive)
    Drive B is "write only" (uploading new LM's)
    -- then swap 'em.

VSLB90.13-19

Protocol

DT-EVENT:

emitted by: All simulators & processors causing DT-relevant events. E.g. a tank fires a round.

information in PDU:

LM affected.

IG's with this LM in LAM must put up a temp. Other IG's just mark the LM "invalid-pending"

Impact location.

DT-Event-Type (crater, earthwork, etc.)

Orientation (earthwork's long axis)

AVAILABLE-NEW-LM:

emitted by: DT Database, announcing an updated LM

information in PDU:

LM affected.

VSLB90.13-20

Protocol

ASK-LM:

emitted by: A simulator with an invalid LM in its LAM or which has just moved across an invalid LM.

information in PDU:

LM id.

NEW-LM:

emitted by: DT Database, broadcasting an updated LM

NOTE: *This is the PDU whose transmission must be minimized; it is the only bulky PDU.*

information in PDU:

LM affected.

List of polys to be deleted, by number

List of polys to be added, with attributes

VSLB90.13-21

The Computation Checklist Revisited

(1) Red artillary computes impact locations

--- and broadcasts them via an (existing) PDU

(2) "Someone" decides bridge is destroyed, reshapes it

(3) "Someone" computes new microterrain for craters

(4) Trafficabilities get updated so tanks can't use bridge

--- these are all done by the DT Processor

(5) Bulldozer's action simulated while cutting the ford

--- the Engineer's Workstation

(6) Rainfall's effects are computed

(7) Track marks are laid down by all parties

--- The DT Database does these functions

VSLB90.13-22

What's Easy? What's Hard?

In increasing order of difficulty:

Earthworks
--- small number of polygons; infrequent

Craters
--- simple to execute, but could have thousands

Track marks
--- everybody makes them, all the time.
--- Uploading the dirty LM's may be overwhelming
+ Ownship responsibility could extend to DR models

Rainfall
--- creates puddles all over the database
--- every low spot in terrain is, in essence, a crater!

Some Hybrid Ideas:

- Do Earthworks as above; leave craters=manholes
- Your turn!

VSLB90.13-23

Discussion and Recommendations

A. What have I missed? (Whole issues?)

B. Is my "rank ordering of difficulty" right?

C. Queries: a bad thing? (Yesterday it seemed so)

--- rationale: "need to know" --> offscreen stuff never crosses the net

D. The above approach REQUIRES all simulators to be using the same IG or at least polygonization scheme..

I claim that with today's technology, no other DT scheme is feasible. Correlation will just be too hard to solve in realtime.

Recommendations:

<<" Standards" imply that >1 organization is DOING it >>

<< Come forward, admit you're doing it, if you are! >>

PRESENTER: KEVIN BACKE

U.S ARMY ENGINEER TOPOGRAPHIC LABORATORIES) DIGITAL CONCEPTS AND ANALYSIS CENTER (USAETL - DCAC)

ASSESSMENT OF ITD AS A POTENTIAL DATA SOURCE FOR GROUND FORCES SIMULATION

ITD BRIEFING OUTLINE

- INTERIM TERRAIN DATA (ITD) DESCRIPTION
- TACTICAL TERRAIN ANALYSIS DATABASE (TTADB) SAMPLE
- STATUS OF DCAC STUDY: USE OF ITD FOR GROUND FORCES SIMULATION

USAETL - DCAC

INTERIM TERRAIN DATA (ITD)

- A DIGITAL TERRAIN [redacted] ANALYSIS PRODUCT

- FULFILL THE ARMY'S NEAR-TERM (1989 - 1994+) REQUIREMENT FOR TACTICAL-LEVEL DIGITAL TOPOGRAPHIC DATA

- USED IN TACTICAL DECISION AIDS SYSTEMS, "SMART WEAPON SYSTEMS, MILITARY GIS SYSTEMS, ...

USETL-DCAC

ITD CONTENT

- SOFTCOPY 1:50K TTADB (Tactical Terrain Analysis Database)
  -- future production from 1:250K PTADB, & enhanced ITD

- CURRENTLY PRODUCED BY DIGITIZING HARDCOPY TTADB'S OVERLAYS

- UNSYMBOLIZED VECTOR DATA ENCODED WITH DESCIPTIVE INFORMATION (Feature Codes and Attribute Values)

- DATA SEGREGATED INTO SIX THEMATIC FILES
  (i.e. slope, vegetation, soils, surface drainage, transportation, and obstacles)

- DTED I (Digital Terrain Elevation Data) SUPPLIED WITH ITD

USAETL - DCAC

ITD FORMAT

- DATA FORMAT: CHAIN-NODE

- EXCHANGE FORMAT: DMA 2-D SLF (Standard Linear Format) 17Nov88

- FEATURE CODING SCHEME: DMAFF (DMA Feature File) Dec83

- MEDIA: 9-TRACK MAGNETIC TAPE (1/2" 1600/6250 BPI)
  --in the future CD-ROM media

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ITD SPECIFICATIONS

- COORDINATE SYSTEM: GEOGRAPHIC (i.e. LAT, LONG)
- HORIZONTAL DATUM - WGS-84;
  VERTICAL DATUM - MEAN SEA LEVEL
- DATA DENSITY: SAME FEATURE DENSITY AS HARDCOPY TTADB (or PTADB) (Killen dataset)
- AREA COVERAGE: for DIGITIZED TTADB - 15 MINUTES X 15 MINUTES;
  PTADB - 1 DEGREE X 1 DEGREE;
  DTED1 - 1 DEGREE X 1 DEGREE
- ACCURACY: NO BETTER THAN BASE MAP
  (1:50K TLM ~50M absolute horizontal accuracy)

USAETL - DCAC

ITD DENSITY & STORAGE

KILLEN DATASET (FORT HOOD, TX)

SLOPE	- 1457 A FEATURES;	101,826 PTS.;	1.9MB
VEG.	- 1093 A FEATURES;	84,738 PTS.;	1.5MB
SOILS	- 659 A FEATURES;	62,698 PTS.;	1.0MB
S.D.	- 845 P,L,A FEATURES;	26,366 PTS.;	0.6MB
TRANS.	- 496 P,L FEATURES;	9,726 PTS.;	0.3MB
OBS.	- 139 L,A FEATURES;	3,382 PTS.;	0.1MB

A = AREA (POLYGON); L = LINE; P = POINT

KILLEN ITD DATASET ~660 SQ. KM

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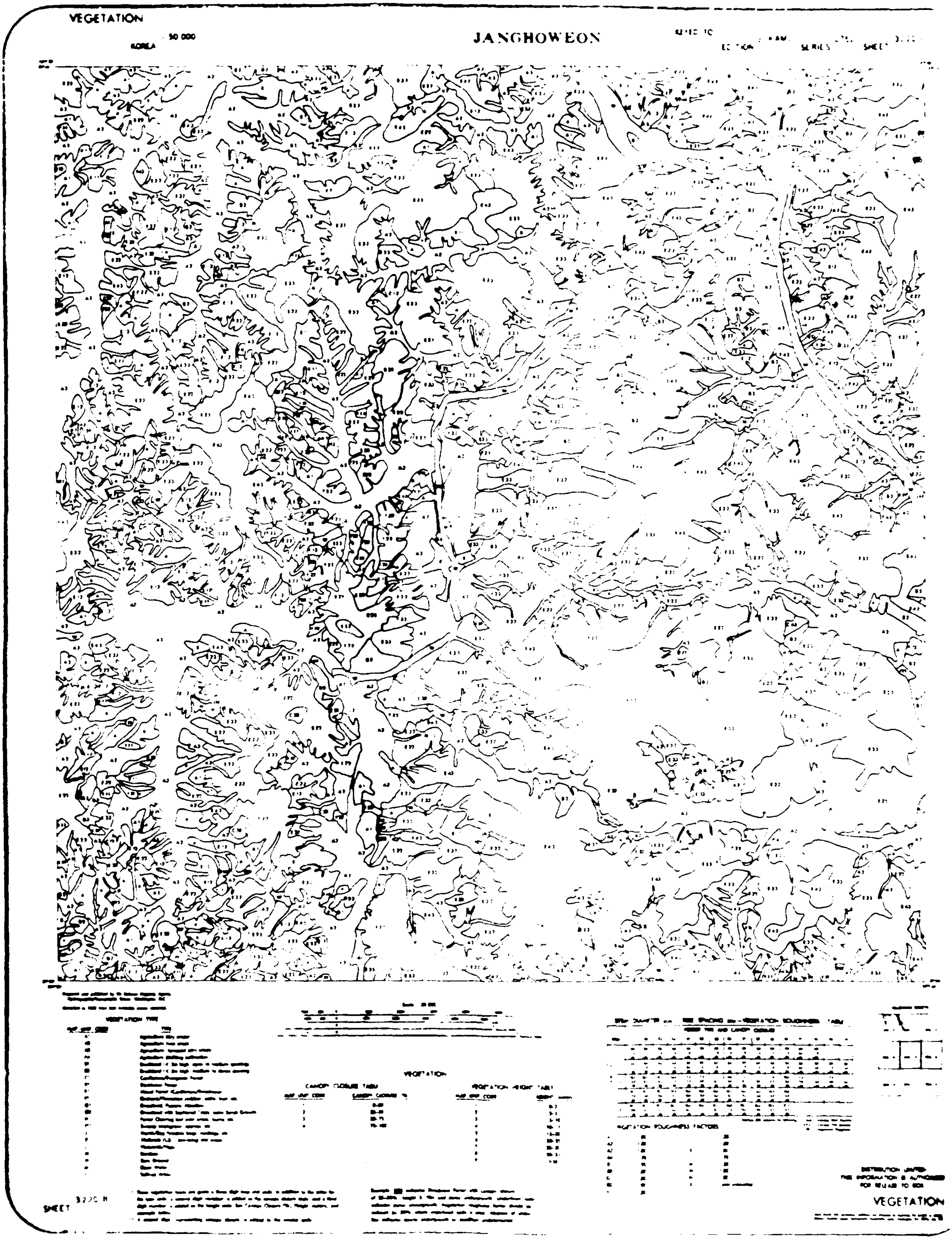
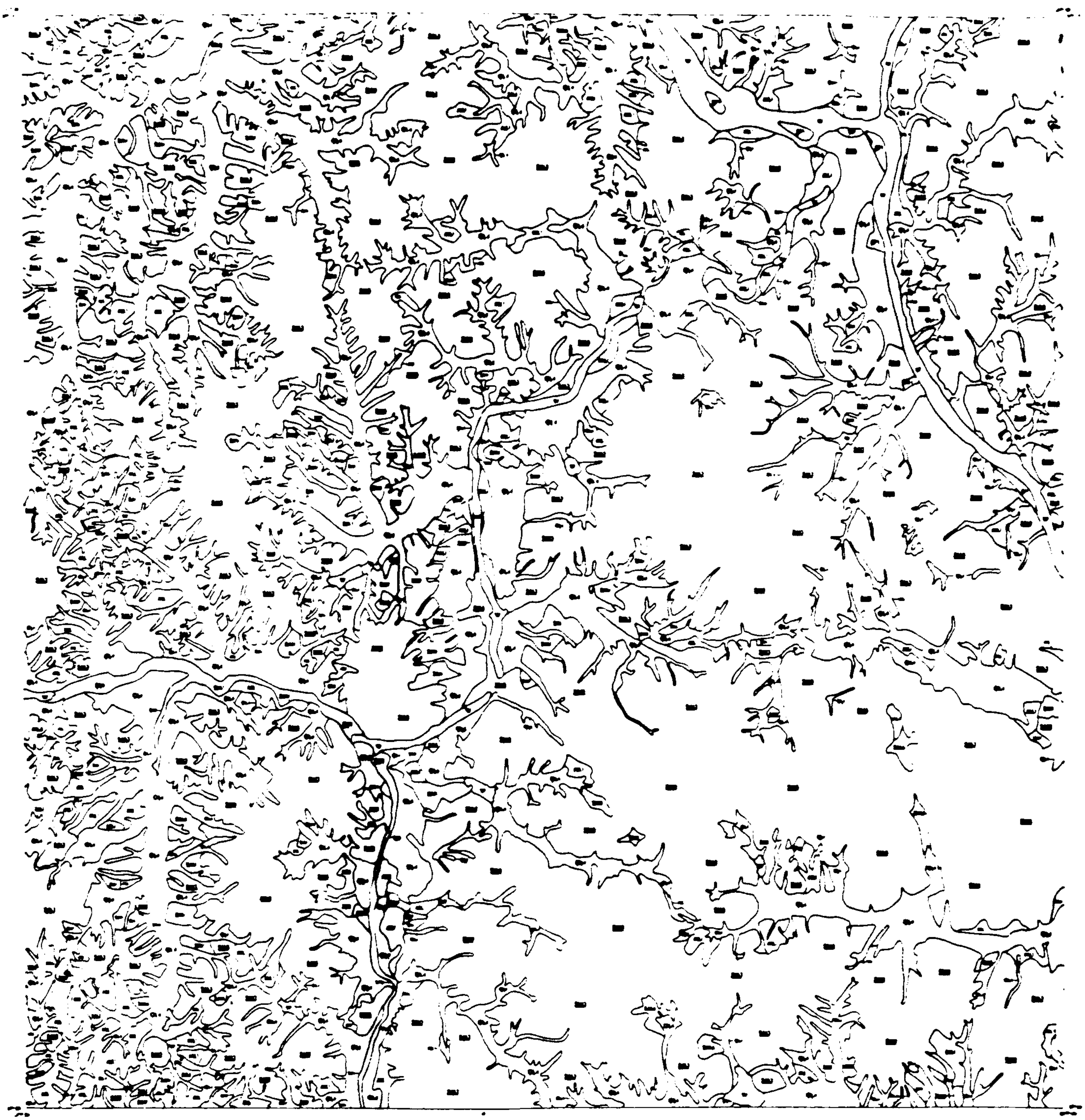

VEGETATION
KOREA
50 000
JANGHOWEON
VEGETATION
DISTRIBUTION LIMITED
THIS INFORMATION IS AUTHORIZED
FOR RELEASE TO DOD
VEGETATION
SHEET 3220 II

KOREA 1:50,000

JANGHOWEON



SURFACE MATERIALS

SOIL TYPE

SURFACE ROUGHNESS

SOIL DEPTH

SOIL MOISTURE

DISTRIBUTION LIMITED
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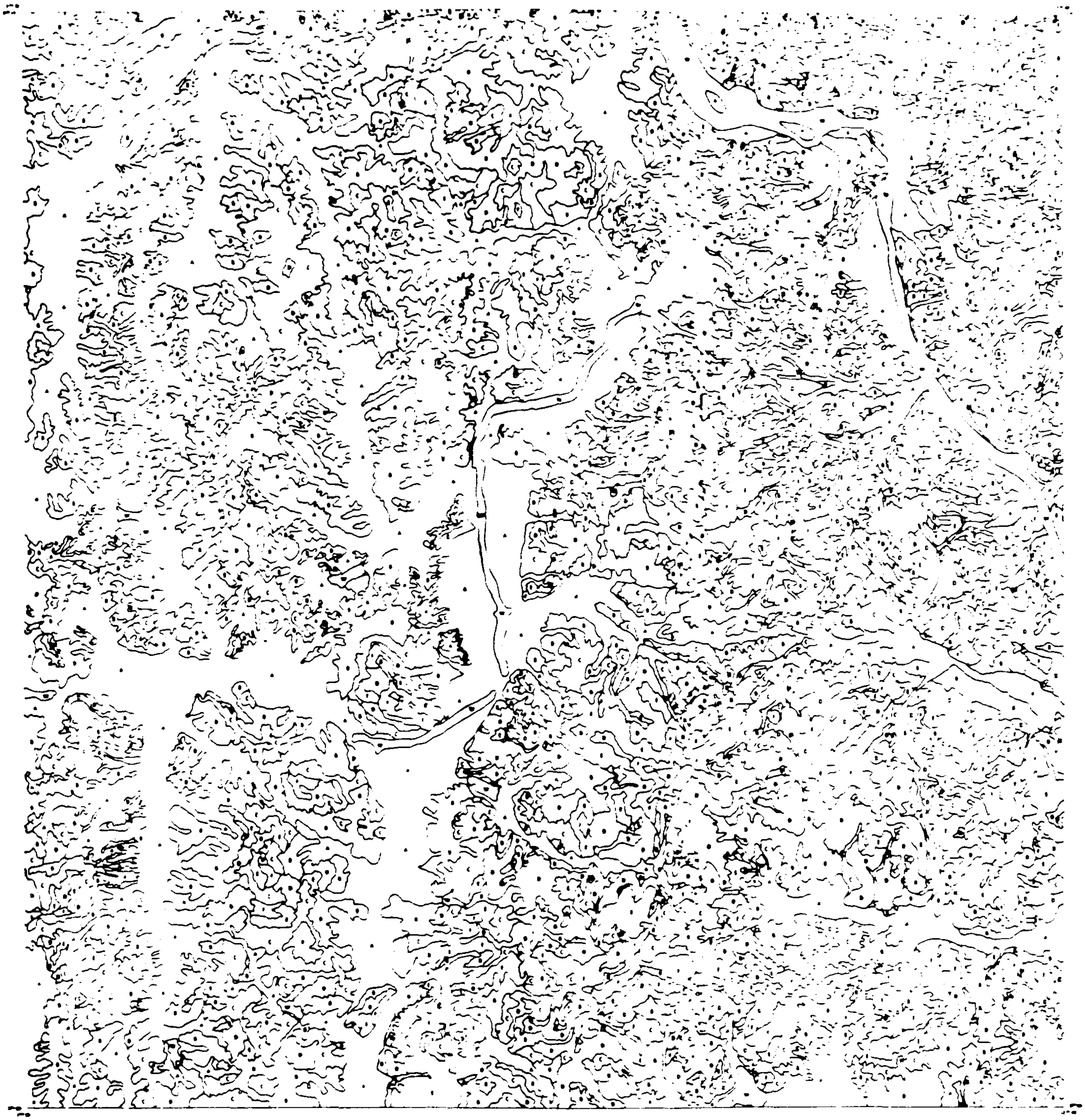
SURFACE MATERIALS

SHEET 3220 II

SURFACE CONFIGURATION (Slope

KOREA 1:50 000

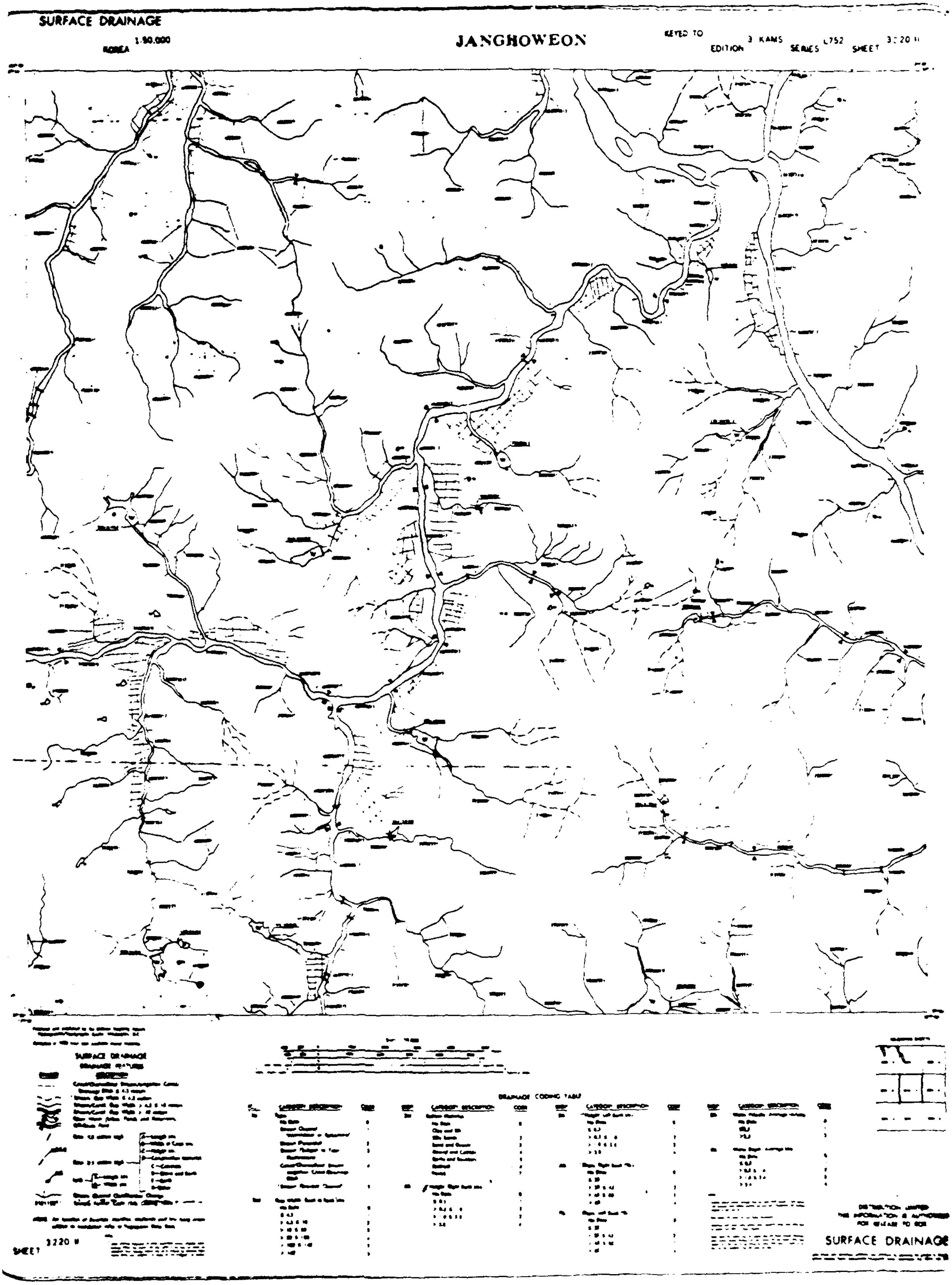
JANGHOWEON

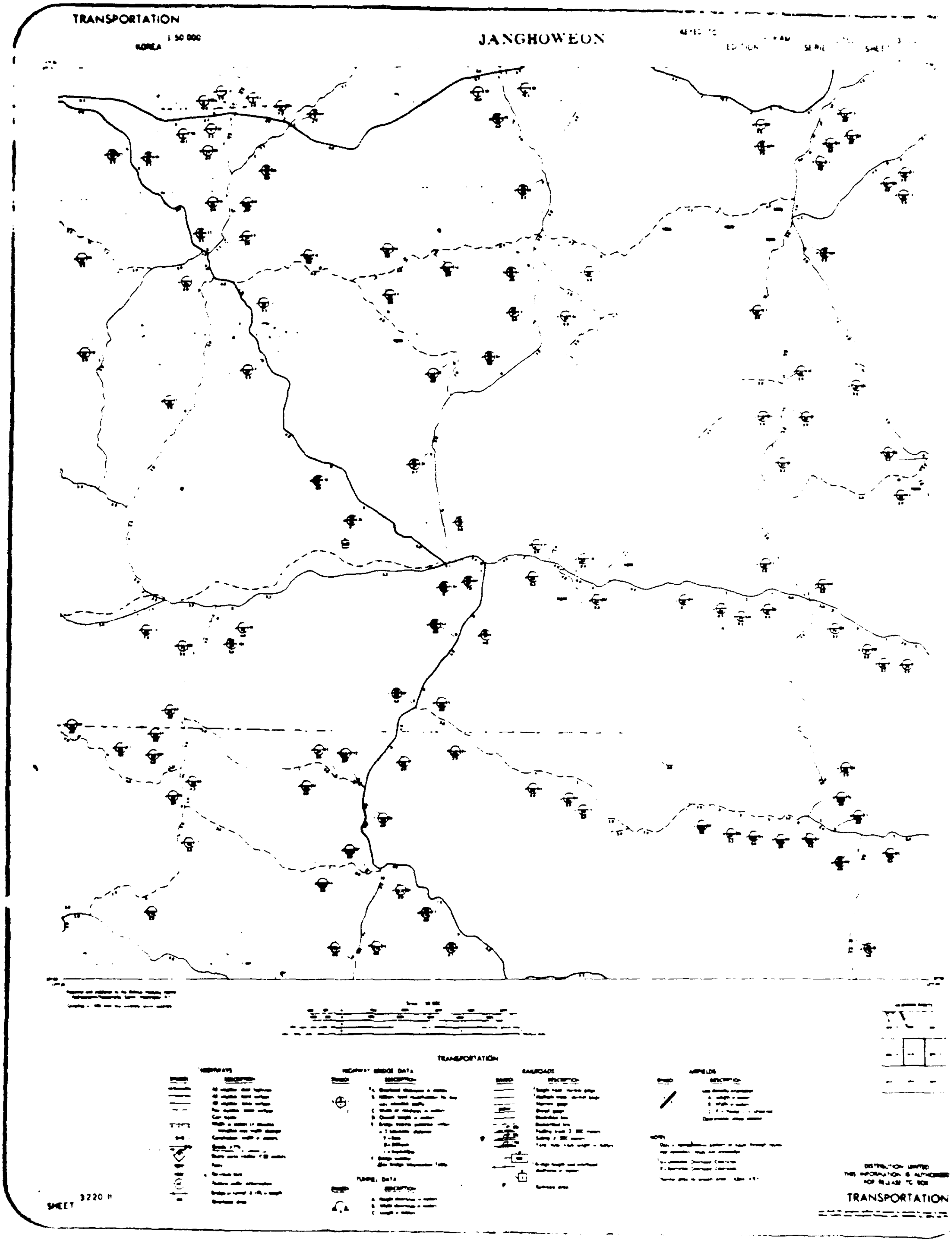


SURFACE CONFIGURATION (SLOPE)

SHEET 3220

SURFACE CONFIGURATION (Slope)


SURFACE DRAINAGE
KOREA 1:50,000
JANGHOWEON
KEYED TO
EDITION 3 KAMS
SERIES L752
SHEET 3220 II
DRAINAGE CODING TABLE
SURFACE DRAINAGE
SHEET 3220 II
SURFACE DRAINAGE


TRANSPORTATION
KOREA
1:50 000
JANGHOWEON
SHEET 3220 II
TRANSPORTATION
TRANSPORTATION

3220 II

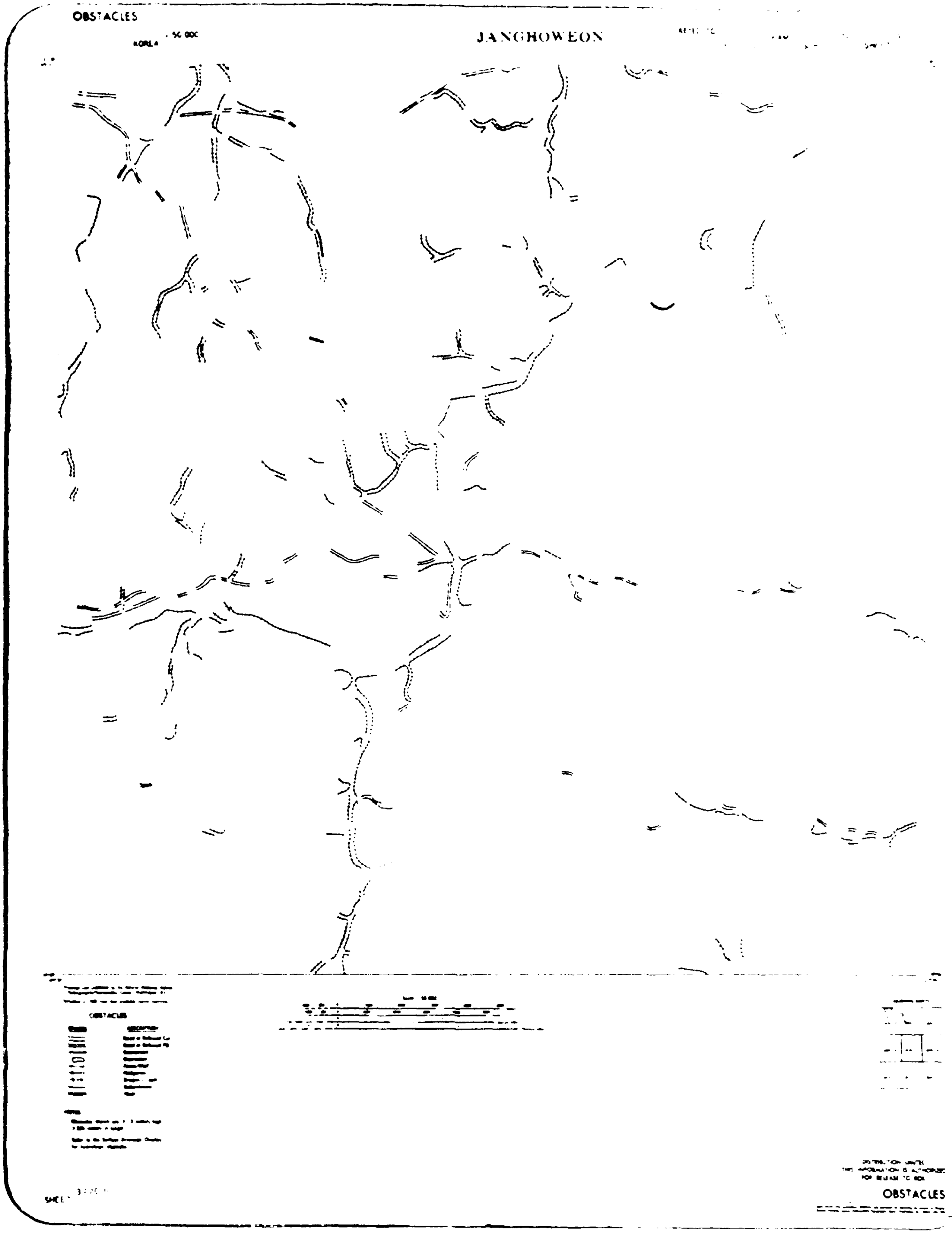
BRIDGE INFORMATION TABLE

1	CS734221				5.0	U				46		D
2	CS734227				5.0	U				6		D
3	CS805329				16.0	U				30		E
4	CS807229				12.5	U				30		E
5	CS705216				10.5	U		30.0	5	150		D
6	CS719217				12.0	U		30.0	3	90		D
7	CS723218				5.5	U				55		E
8	CS739214				5.2	U		[illegible]	4	44		E
9	CS741215		76		6.7	U	Reinforced Concrete	5.0	2	10	2.0	E
10	CS810212		66		6.5	E	Reinforced Concrete	19.0	4	46	2.0	D
11	CS880218				9.0	E		16.0	.	32		D
12	CS882217		56		9.0	U				100		E
13	CS880213				5.0	E				20		D
14	CS905218				5.0	D				15		D
15	CS691209	30	90		5.5	D	Reinforced Concrete	5.0	4	23	3.0	D
16	CS692202		50		5.7	D	Reinforced Concrete	5.0	9	99	4.0	D
17	CS721208				4.0	E				50		E
18	CS725206	30	50		6.0	E	Reinforced Concrete	10.0	5	50	2.5	E
19	CS899205				5.0	U				15		D
20	CS961209				5.0	U				10		D
21	CS924202				5.0	U				26		D
22	CS920208				5.0	U				12		D
23	CS535209				5.0	C				16		D
24	CS721196				5.0	U				10		E
25	CS881197	36	55		5.5	U	Reinforced Concrete	10.3	2	21	3.5	D
26	CS721187				5.0	E				10		E
27	CS679178				5.0	E				70		D
28	CS713178	30	65		5.5	C	Reinforced Concrete	10.4	5	52	4.0	D
29	CS727178				5.0	E				8		E
30	CS749178				5.0	E				10		D
31	CS776173				5.0	D				10		D
32	CS783175				5.0	D				10		D
33	CS881172		55		4.0	D	Reinforced Concrete	10.3	4	41	4.0	D
34	CS834174				5.0	D				15		D
35	CS897175		66		5.2	D	Reinforced Concrete	15.0	4	60	2.8	E
36	CS712161				5.0	D				11		D
37	CS721165				5.5	D				12		D
38	CS761166				5.0	D				6		D
39	CS820164				5.0	D				60		D
40	CS806162				5.0	D				15		D
41	CS815152	30	65		5.0	D	Reinforced Concrete	6.0	1	6	2.0	D
42	CS661145				5.0	D				10		E
43	CS731144				5.5	D				9		D
44	CS789142				4.0	U				31		D
45	CS805133	30	90		5.0	D	Reinforced Concrete	12.0	2	24	4.0	D
46	CS895134				5.0	U				40		D
47	CS915134				5.0	D				30		D
48	CS706126				5.0	D				5		D
49	CS809124				5.0	D				24		D
50	CS881123				5.0	U				21		D
51	CS792115	30	55		6.7	C	Reinforced Concrete	9.7	3	29	3.0	C
52	CS807116				5.5	D				6		D
53	CS934116				5.5	D				80		D
54	CS752109	30	65		6.0	D	Reinforced Concrete	5.0	1	5	2.0	D
55	CS925105				5.0	D				10		D
56	CS709099	30	50		9.5	D		5.7	6	35	3.0	D
57	CS784099		55		5.0	D	Reinforced Concrete	10.0			1.5	D
58	CS718088		60		5.2	D	Asph. Tmte.	15.0	4	56	5.6	
59	CS736083	30	90		7.0	D	Asph. Tmte.	10.9	6	64	3.0	C
60	CS809082				8.5	D		11.0	.	44		D
61	CS815080				5.0	D				75		E
62	CS800087				5.0	D				10		D
63	CS821077				8.0	D				90		E
64	CS829074				8.0	D				35		E
65	CS869077				8.5	C		9.0		10		D
66	CS873070				8.5	U		11.0	.	11		D
67	CS887070				8.0	U				20		D
68	CS869066				7.0	U		6.0	.	16		E
69	CS771065	30	60		5.0	U	Reinforced Concrete	15.0	12	185	3.0	D
70	CS710066				6.0	U		15.0	3	45		C
71	CS794065	30	55		6.0	U	Reinforced Concrete	[illegible]			[illegible]	D
72	CS879066				8.0	U				65		C
73	CS894064				5.0					65		
74	CS901066				[illegible]					30		
75	CS707095				5.0					20		
76	CS780057	30	60		6.5		Reinforced Concrete	[illegible]		[illegible]	2.5	
77	CS881059				5.5					20		D
78	CS922056				5.5					[illegible]		
79	CS929054				5.0	U				27		C
80	CS778041				6.0	U				8		C
81	CS704034				4.0	U				8		E
82	CS775037	30	90		6.0	U	Reinforced Concrete	11.9	3	33	2.5	D
83	CS673021				4.0	D				16		E
84	CS679022				4.0	U				15		C
85	CS768026				6.0	U				[illegible]		C
86	CS791028				5.0	U				24		C
87	CS790033				5.0	C				29		C
88	CS701019				4.0	U				9		C
89	CS702018				4.5	U				8		C
90	CS738019				5.0	U				16		E
91	CS752015				5.0	D				15		E
92	CS757016				5.0	D				111		D
93	CS813044				5.0	D				10		D
94	CS826013				5.0	D				10		C
95	CS901011				5.0	D				20		D
96	CS701006				5.0	D				15		E
97	CS704008				5.0	D				10		C
98	CS759008				6.0	U				36		D
99	CS830009				5.0	U				6		E
100	CS858005				5.0	D				30		C
101	CS869005				5.5	U				25		C
102	CS875003				5.0	D				16		C
103	CS884004				5.0	U				10		C
104	CS893000				5.0	U				40		C
105	CS890999				6.0	U				26		C
106	CS902997				6.0	U				13		C
107	CS912993	30	60		6.0	D	Reinforced Concrete	12.0	5	60	2.0	C
108	CS921995				8.0	U				70		C
109	CS743988				5.0	D				16		E
110	CS761986				5.5	U				87		C
111	CS764988				6.0	U				50		C
112	CS689979				5.0	C				[illegible]		C
113	CS782978	30	90		6.8	U	Reinforced Concrete	12.3	.	13	1.5	E
114	CS757969				4.0	C				10		E
115	CS788967	30	90		6.7	C	Reinforced Concrete	12.0	.	12	1.5	C
116	CS908965	25	50		6.2	D	Reinforced Concrete	8.0	.	8	2.5	C
117	CS755959				6.0	D				11		C

DISTRIBUTION LIMITED—THIS INFORMATION IS AUTHORIZED FOR RELEASE TO [illegible]

JANGHOWEON

3220 II


OBSTACLES
KOREA
JANGHOWEON
OBSTACLES
OBSTACLES

STUDY POTENTIAL OF ITD TO SUPPORT GROUND FORCES SIMULATION (P2851/RRDB)

- CONTENT (P2851's SSDB vs. ITD)
  (Standard Simulator Database)
- RESOLUTION
- STORAGE REQUIREMENTS
- FORMAT
- AREA COVERAGE REQUIREMENTS

USAETL - DCAC

CONTENT ISSUE

- RECOMMENDATION: INCORPORATE ALL ITD INTO SSDB

- ITD MAY CONTAINS MORE INFO THAN SIMULATORS WILL MODEL

- FURTHER INVESTIGATION: STUDY METHODS TO INTELLIGENTLY THIN DATA WITHOUT LOSING INFO INTEGRITY

- POSSIBLE SOLUTION: INPUT INFORMATION FROM SLOPE, VEG, & SOILS OVERLAY INTO MOBILITY MODEL

- MOBILITY MODEL PRODUCES SINGLE POLYGON DATA FILE OF SPEED RANGES OR "GO", "SLOW", "NO GO" AREAS

USAETL - DCAC

RESOLUTION ISSUE

- ITD MAPS INTO 30M-100M SSDB LOD (Level of Detail)
- NO NUMERICAL ACCURACY DEFINED FOR ITD
- SSDB RESOLUTION DEFINED USING RASTER DEFINITION WHEREAS ITD IS A VECTOR DATASET
- DATA DENSITY INFORMATION CALCULATED FOR A SAMPLE ITD DATASET (Killen, Texas in vicinity of Ft. Hood)

USAETL - DCAC

STORAGE ISSUE

- TAPE STORAGE FOR ITD DATASET (six thematic files) ~6 - 10 MB
  (with enhanced transportation)

- DTED I ~3 MB
  (only need 15' x 15' matrix to cover ITD cell from TTADB
  --substantial reduction in file size

- SOILS, VEG, & SLOPE (full area coverage) POLYGON DATA FILES MAKE UP MAJORITY OF STORAGE REQUIREMENT

- FT. HOOD DATASET -- 5.4 MB (total for six thematic files);
  SOILS, VEG, SLOPE - 4.5 MB;
  SURFACE DRAINAGE, TRANSPORTATION, OBSTACLES - 1 MB

USAETL - DCAC

FORMAT ISSUE

- DATA FORMAT: ITD - CHAIN NODE (SLF);
  SSDB - POLYGON

- IN THE FUTURE SSDB WILL SUPPORT FOR CHAIN-NODE DATA FORMAT

- CODING SCHEME: ITD - DMAFF; SSDB - "FACS - LIKE"

- CODING SCHEMES SIMILAR FOR FEATURE CODING; MAPPING FROM ITD TO SSDB FOR ATTRIBUTES?

- CONTRACTOR STATED ADDING FEATURE CODES AND ATTRIBUTE CODES IS TRIVIAL AS LONG AS IT FOLLOWS RECORD FORMAT

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AREA REQUIREMENTS ISSUE

- MOST ITD CELL PRODUCTION CURRENTLY PRIORITIZED OVER GERMANY AND KOREA
- FOUR COMPLETED FOR FORT HOOD, TEXAS
- ENHANCED TRANSPORTATION DELAYING PRODUCTION SCHEDULE
- MANY CELLS REQUIRED FOR GERMANY MATCH ARMY'S SIMNET PROGRAM'S AREA REQUIREMENTS FOR DIGITAL TOPOGRAPHIC DATA (DTD)
- AREA REQUIREMENT INFORMATION TO MEET SIMULATION DTD AREA REQUIREMENT NOT AVAILABLE AT THIS TIME

USAETL - DCAC

SUMMARY

- ITD IS A ROBUST DIGITAL TOPOGRAPHIC DATABASE
- WELL SUITED TO SUPPORT ARMY'S REQUIREMENT FOR DIGITAL DATA TO BE USED IN GROUND FORCES SIMULATION
- RECOMMENDATION: INCORPORATE FULL ITD DATASET INTO SSDB
- FURTHER INVESTIGATION: HOW CAN ITD DATA VOLUME BE REDUCED WITHOUT LOSING VALUABLE INFORMATION?

USAETL - DCAC

Communications Protocols Working Group

Ron Hofer
Chairman

0096-1222

Interface & Time/Mission Critical Subgroup

Mike McGaugh
Joe Brann
Chairmen

ARTICULATED PARTS

ISSUES

Dr. Eytan Pollak
GE–SCSD
Daytona Beach
Florida 32015

INTERFACE WORKING GROUP
ARTICULATED PARTS

ISSUES :

- NUMBER OF DOF
- MECHNISIM FOR INDEXING
- EXTRAPOLATION
- DATABASE CORRELATION

ARTICULATED PARTS

EXAMPLES OF MODELS USING ARTICULATED PARTS:

- TANK TURRET
- SPACE SHUTTLE ARM (REMOTE MANIPULATOR SYSTEM)
- SPACE SHUTTLE DOORS AND REFLECTORS
- HELICOPTER ROPE (WITH SWING) WAVING IN THE WIND
- HELICOPTER ROTORS
- AIRPLANE LANDING GEAR, WING FLAPS, RUDDER ELEVATORS
- AIRPORT TERMINAL JETWAY (TRANSLATIONAL DEGREES OF FREEDOM)
- REFUELING BOOM AND NOZZLE (ANGULAR AND TRANSLATIONAL DOFs)
- ARTICULATED MAN (BODY, HEAD, ARMS (UPPER, FOREARM, AND HAND), LEGS (THIGH, CALF, FOOT)

INTERFACE WORKING GROUP
ARTICULATED PARTS

__DATA REQUIRED FOR MOVING MODEL OR ARTICULATED PART DYNAMICS UPDATE__

MOVING MODEL ID NUMBER

ARTICULATED PART INDEX
(0 IF ROOT MODEL)

POSITION (X, Y, Z)

ATTITUDE (ROLL, PITCH, YAW)

TIME STAMP

POSITION VELOCITY

ATTITUDE VELOCITY

POSITION ACCELERATION

ATTITUDE ACCELERATION

Communication Architecture Subgroup

Steve Blumenthal
Chairman

0091-1176

COMMUNICATIONS ARCHITECTURE SUBGROUP MEETING
AUGUST 8, 1990

I.	REVIEW	Al Kerecman
II.	IST UPDATE	Dr. Henry Williams
III.	SINCGARS VOICE NETWORK SIMULATOR	Larry Goldberg
IV.	BB&N PRESENTATION	Steven Blumenthal
V.	ISSUES FROM POSITION PAPERS	
VI.	REQUIRED NETWORK SERVICES	
VII.	ARCHITECTURE - Network Management - Simulation Management - Configuration Management & Network Support - Security	
VIII.	CONFORMANCE & INTEROPERABILITY - Procedures - Test Tools - Network Support	
IX.	PROGRAM PRIORITIZATION LIST	

REVIEW

Al Kerecman
USACECOM

0096-1224

I. DISTRIBUTED SIMULATOR ARCHITECTURE [DSA] DEVELOPMENT

Purpose: to replace the SIMNET association layer protocols with existing COTS protocols for proof of OSI profile implementation concept.

A. Analyze the BBN SIMNET Association Layer Interface for functions which can be provided by OSI.

B. Decouple SIMNET modules which embrace other than OSI Layer 7 functions; resulting in an Interactive Simulation Protocol [ISP] capable of being coupled to OSI.

C. Submit ISP to ANSI for consideration as an OSI Application Layer Simulation Standard.

D. Replace ethernet with 802.3

E. Interface ISP to ISODE for test purposes.
Run the ISP appearance packet over ISODE.

F. Compare the non-multicast ISODE performance with the BBN SIMNET implementation.

G. Decouple TCP/IP from ISODE and Replace TCP/IP with HTP, VMTP/IP, and UDP Multicast IP; test the performance characteristics of each in the ISODE altered profile; compare performance with BBN SIMNET.

H. Implement and tune one substack from G above based upon ANSI/OSI coordination and acceptable performance.

I. Couple FDDI into simulator platforms and run comparison performance tests against the 802.3 supported units.

J. Provide the Distributed Simulators Profile [DSCP] to PM TRADE for submission to JCS, as the standard DoD simulator networking profile.

K. Encourage vendors to make the source code of the ISP reference implementation available in the public domain free of charge.

ENCLOSURE 2

II. INTERACTIVE SIMULATION PROTOCOL (ISP)

Purpose: To produce a standard application layer protocol for distributed simulators networked in an OSI environment.

A. From the ISP Standard Development effort, (IA, IB, and IC), document the resultant ISP and distribute it as the draft application layer standard.

B. Provide attendance from UCF IST to the NIST OSI Workshop. Attend three parallel sessions on a regular basis for the following reasons:

1. Application Layer Sessions - to promote, discuss, and defend the ISP submission.

2. Transport Layer Sessions - to promote, discuss, and defend the acceptance of HTP, UMTP, and/or UDP into the OSI family for multicast requirements of ISP.

3. Network Layer Sessions - to promote, discuss, and defend the need for a multicast internet to support the ISP.

C. Submit the ISP through PM TRADE to JCS for consideration and backing as the OSI Application Layer standard for Simulators.

D. Coordinate the JCS and NIST/ANSI/ISO efforts to a successful conclusion. Publish the ISP standard.

III. WAN CHARACTERISTICS FOR DISTRIBUTED SIMULATORS ARCHITECTURE [DSA] APPLICATION

PURPOSE: To determine the WAN characteristics of import for DSA applications.

1. Bandwidth - T1 and higher for short duration (weeks) training exercises [Exercises planned in advance].
   - 9.6KBPS to 56KBPS for continuous operation [dependent upon needs].

2. Minimum cost and setup/teardown time for the short term wide band support.

3. Guaranteed level of service, preferably non-switched during exercises (could become mandatory for secure operation).

4. LAN-WAN gateways at the LAN sites, not at the Long Haul Vendors facilities.

5. COMSEC facilities at the LAN sites.

6. Centrally managed with distributed submanagement functions.

7. Committed to OSI for COTS/NDI cost effective implementations.

8. Must be able to network training simulators with fielded and future battlefield OPFACs, Platforms, and Command Posts; providing these simulators with their required battlefield C3I information.

9. Must support a comprehensive security policy and implementation.

IV. OPEN SYSTEMS INTERCONNECT [OSI] ARCHITECTURE

Purpose: To provide the PM TRADE Distributed Simulators with a communications architecture that is supportable through Commercial Off The Shelf/ Non-Developmental Item [COTS/NDI] material; and to provide these distributed simulators with the ability to exchange C3I information as they would in a battlefield environment.

The network concept for the Distributed Simulator Architecture [DSA] is at enclosure 4. The DSA protocol profiles, for clarity, are presented in segments under the same enclosure.

A. SEGMENT I - supporting the Interactive Simulation Protocol [ISP]. This communications protocol profile is the pictoral representation of the DSA required to provide service to/for the ISP.

B. SEGMENT II - supporting the C3I communication exchange requirements. This communications protocol profile is the pictoral representation of the DSA necessary to support the C3I information exchange among and between the distributed simulators. It carries GOSIP, DDN, and tactical communication profiles which provide interconnect with/to the Army Common Hardware and Software and Maneuver Control Systems as well as ATACS, SINCGARS, MSE, EPLRS, and JTIDS communications systems. This software, known as MCS Version 11, written in ADA for the 68,000 family of processors running under the UNIX operating system will be available, for free, from PM OPTADS and PEO CCS.

C. SEGMENT III - supporting the real time TADIL traffic. This communications protocol profile is the pictoral representation of the DSA required for passage of real-time track data to/among/between the distributed simulators by their supporting and/or supported elements. It is not an OSI conforming stack, but is implementible with an OSI conforming COTS lower layer profile [1-4] directly interfaced to the JCS and DoD approved TADILS. This non-conforming profile is necessary to provide real time service to the implementing OPFACS, Platforms, and Command Posts until the TADILS can be restructured to conform with the OSI architecture.

D. SEGMENT IV - composite DSA [TBD]. This is the resultant of A+B+C above. Specific implementations will be defined in the future for the varrying simulator configurations/interactions and for the LAN/WAN gateways, bridges, and routers.

E. SEGMENT V - supporting security functions of the network [TBD]. This segment shall address the security overlay to the DSA for exchange of classified information. Simulator and network functional implementations will be addressed as well as the network management interfaces.

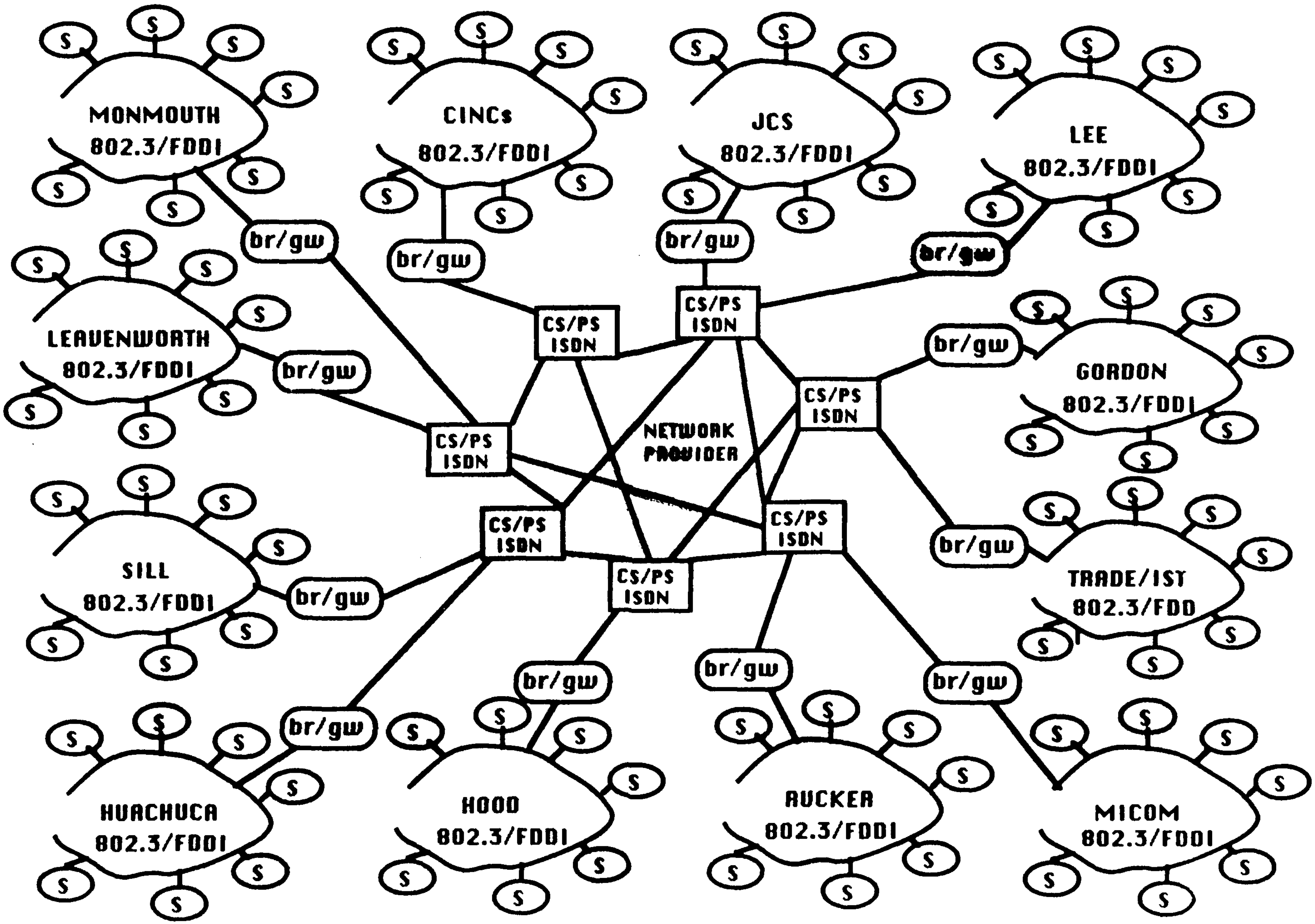
IV. OPEN SYSTEMS INTERCONNECT [OSI] ARCHITECTURE [cont]

F. SEGMENT VI - supporting network management and administration [TBD]. This segment shall address the network management and administration functions required by the DSA, including the the Configuration Management and Hardware/Software Support requirements of both the simulators and the network.

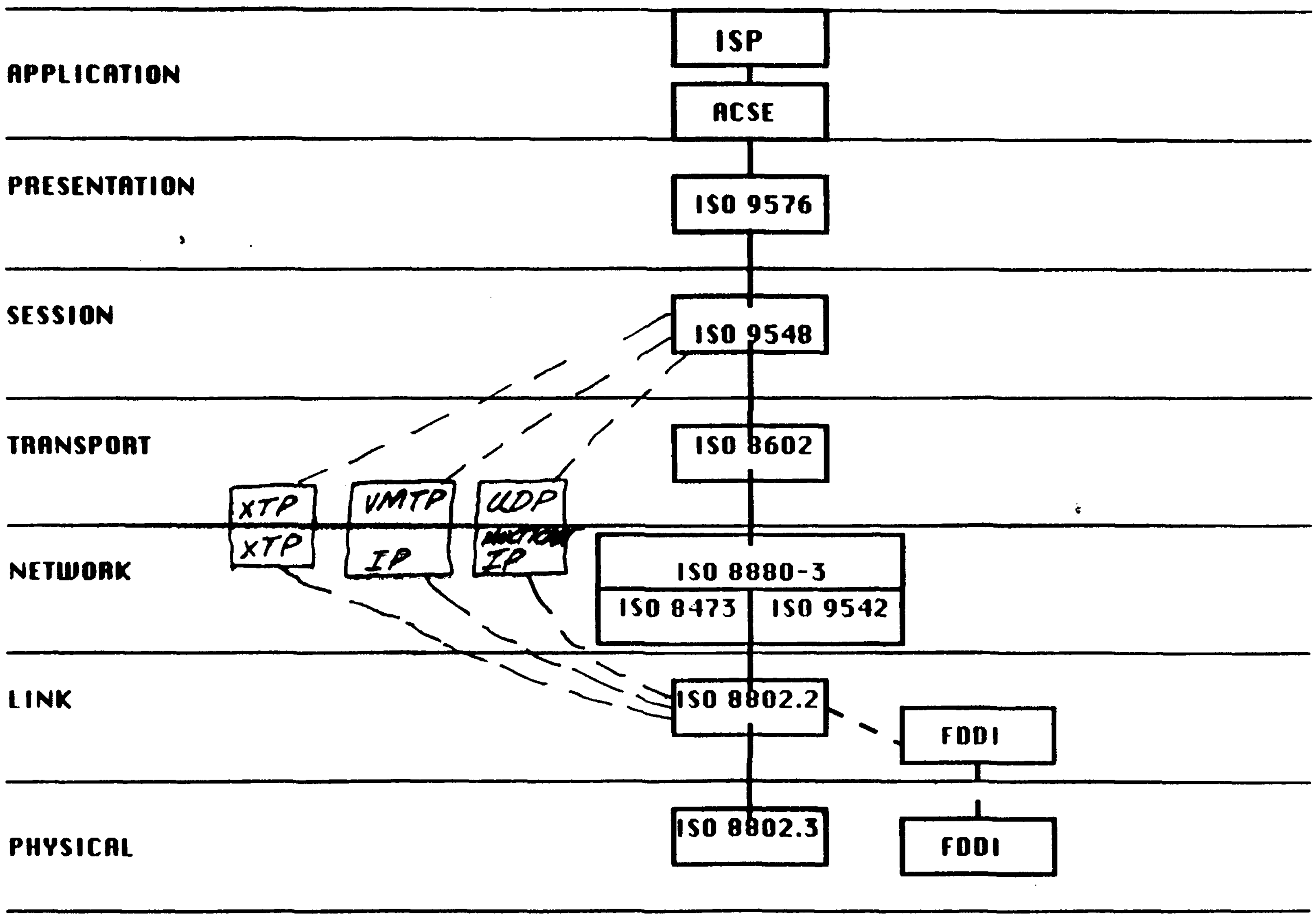
Consolidated output of the working group, briefed to the conference at large, consisted of general statements of intent as follows:

0) Hosting Present Standards - Recommend the embedding of DoD Standards such as JCS Pub 25 *(USMTFs)*, JCS Pub 6 *(TADILs A,B,C)*, TADIL J TIDP Vols. II & VI, NATO STANAGS, Links 11 & 16, etc., into the SIMNET Packet Data Unit (PDU) to provide the Command and Control information to the S/Ts.
1) Security - SIMNET must be capable of networking both unclassified and classified environments *(up to secret)*.
2) Present protocol profile implementation - This task requests that BB&N quantify their protocol profile in OSI parlance.
3) Time Stamping/Latency - [SIMNET requires that real-time packets traversing the network be provided a mechanism to handle the packet latency issue]. Determine the proper approach, taking into account both information and hardware/software available from the Joint Interoperability and Evaluation System (JIES) and from the Autonomous Land Vehicle (ALV) programs.
4) ISO-OSI Profile Recommendations - Define and determine a specific set of OSI protocol profiles, (within the framework of GOSIP Phase I and Phase II, and compatible with the NATO OSI transition strategy adopted by member nations), to be implemented by all SIMNET operable products, as articulated within the SIMNET specification. Includes evolution to FDDI and ISDN.
5) NIST, ITS/NTIA, and University Support - Define the support roles of the above institutions and academia as a minimum.
6) Networking Resources - Define and determine the cooperative opportunities and sharring of networking resources for efficient and effective SIMNET evolution. Defines interactions in, among, and between MILNET, DSNET, SCINET, AIN, JITS, JIES, CALS, NATO and services such as FTS 2000.

PICTORAL OF DISTRIBUTED SIMULATOR ARCHITECTURE NETWORK CONCEPT



SEGMENT I - INTERACTIVE SIMULATION PROTOCOL PROFILE FOR DSA

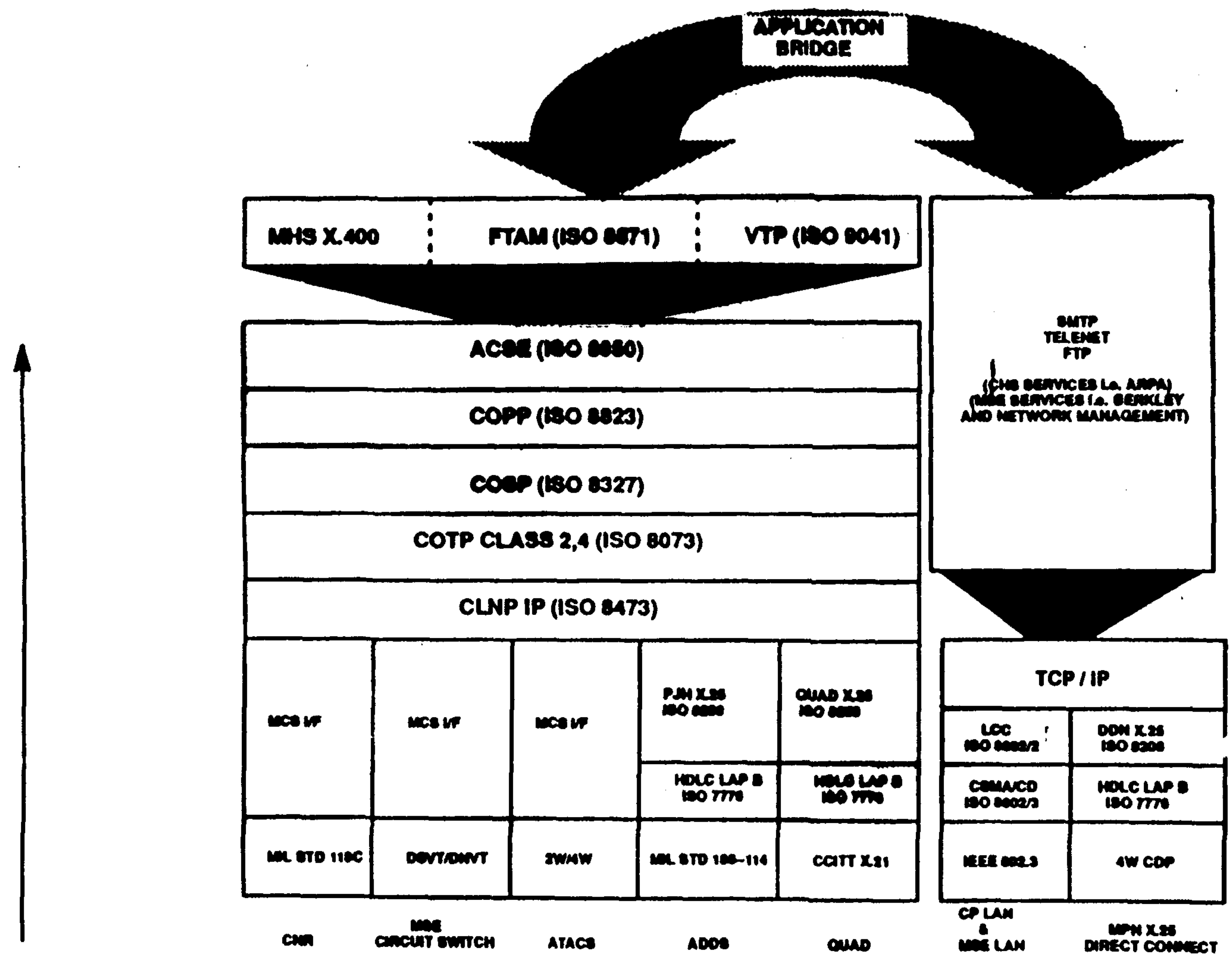


SEGMENT II - C3I COMMUNICATIONS

UNCLASSIFIED

PROGRAM EXECUTIVE OFFICE COMMAND & CONTROL SYSTEMS — SYSTEMS ENGINEERING OFFICE

BFA TO BFA PROTOCOLS
–RECOMMENDED 'STACKS'–



ISSUES: 1. USE OF FTAM AND VTP OVER HALF–DUPLEX SYSTEMS ?
2. FURTHER DEFINITION OF MSE NETWORK MANAGEMENT SERVICES

UNCLASSIFIED

IST UPDATE
For The Communications Architecture Subgroup

Dr. Henry Williams
University of Central Florida

0091-1184

AGENDA

- Objectives
- OSI Reference Model Re-visited
- ISO Development Environment (ISODE)
- Approach to Building OSI Stack
- Status of Current IST OSI Activities
- Distributed Interactive Simulation Environment (DISE) Testbed Concept
- Summary

0072-1038

OBJECTIVES

- To present a concept/ implementation scheme for a networked, data communications testbed environment using general-purpose protocols.
- To develop a network environment for capturing and analyzing empirical data on message delays and loading in a distributed simulation environment.
- To develop/provide a platform for needs assessment such as local and long-haul, multicasting capabilities.
- To create a networking environment for generating answers to various questions/issues pertaining to distributed simulation.

0072-1039

OSI REFERENCE MODEL

Application
Presentation
Session
Transport
Network
Data Link
Physical

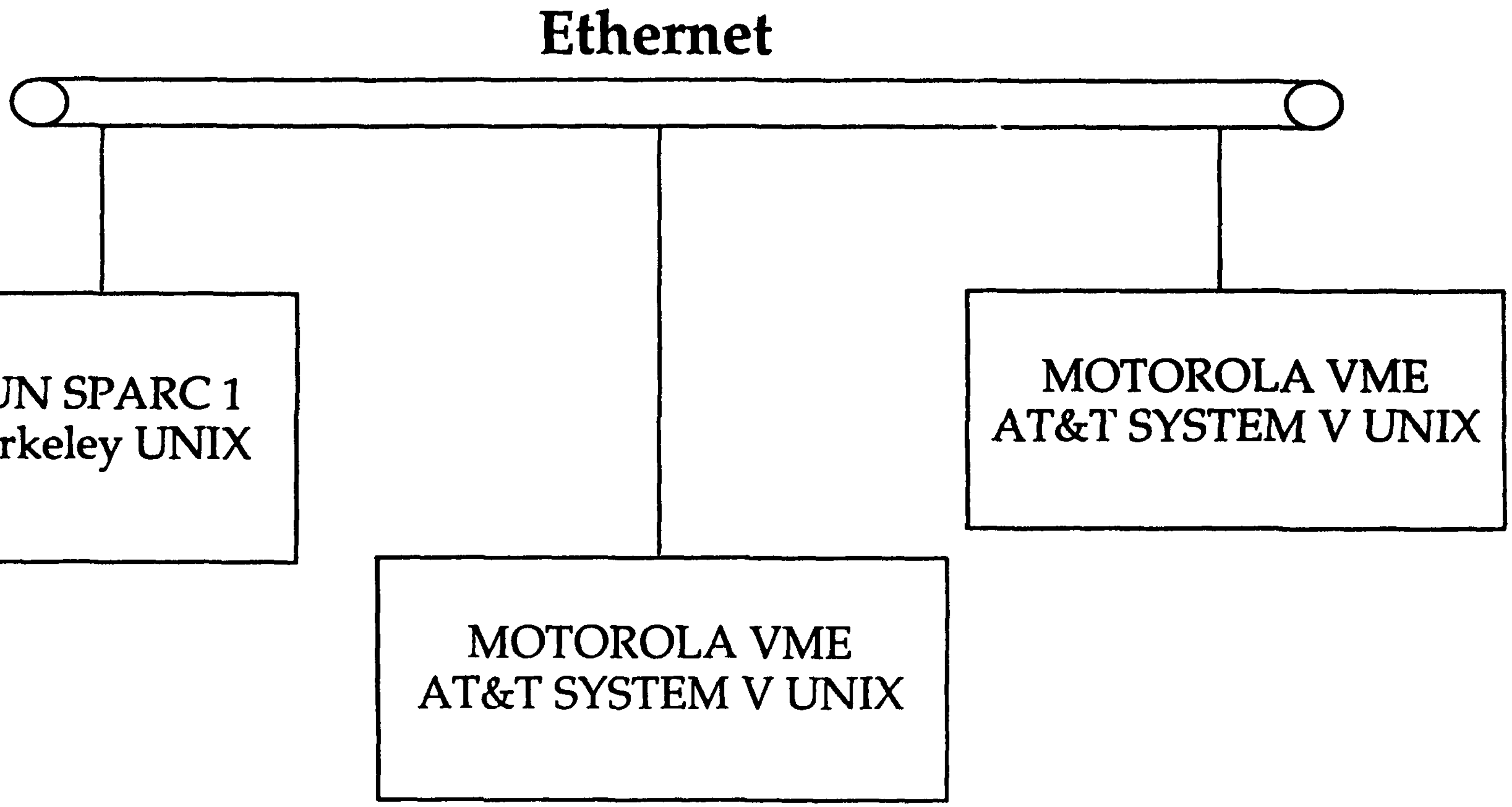
0072-1040

ISO DEVELOPMENT ENVIRONMENT (ISODE)

- Public domain software package which implements the upper-layers (7,6,5) of the OSI reference model.
- Uses UNIX-based (TCP/IP) network services.
- Intended as a tool for studying OSI - not as a base for developing OSI production software.
- ISODE versions available for UNIX-based machines.
- ISODE versions being developed for VMS- and DOS- based machines.

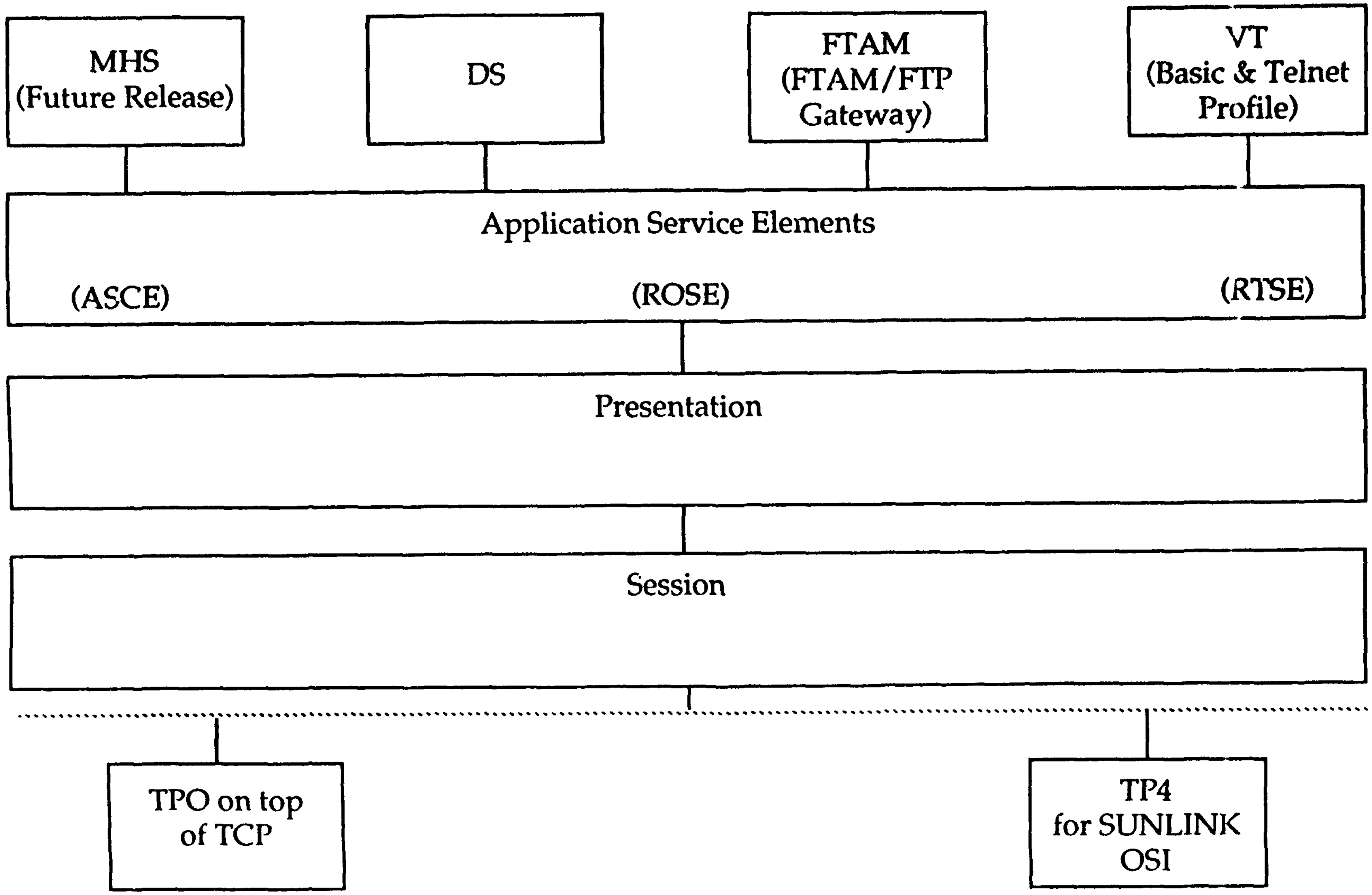
0072-1041

ISODE SYSTEM ENVIRONMENT (IST)



0072-1042

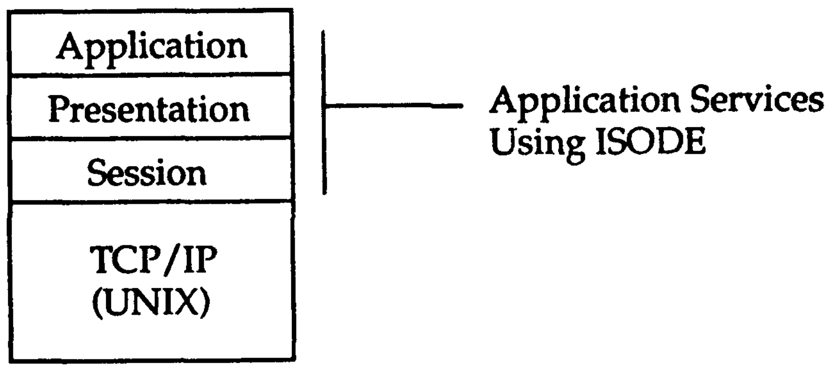
ELEMENTS OF ISODE 6.0



0072-1043

CONSTRUCTION OF OSI STACK

Phase I: Quasi - OSI stack

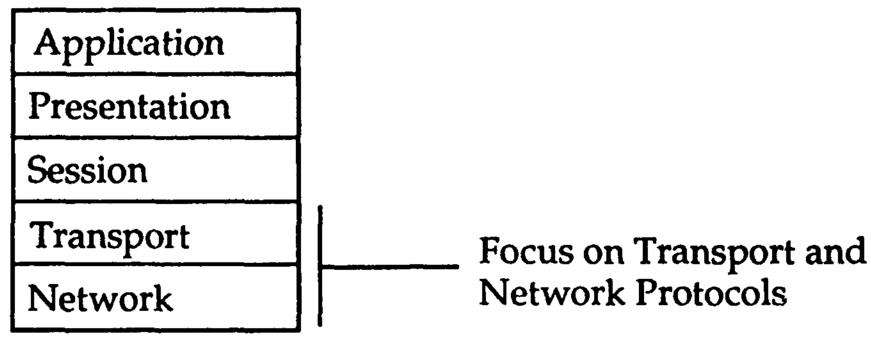


- Connection - Oriented Services
- Multi - Initiator/Responder Processes

0072-1044

CONSTRUCTION OF OSI STACK (CONT)

- Phase II : Portable OSI Stack



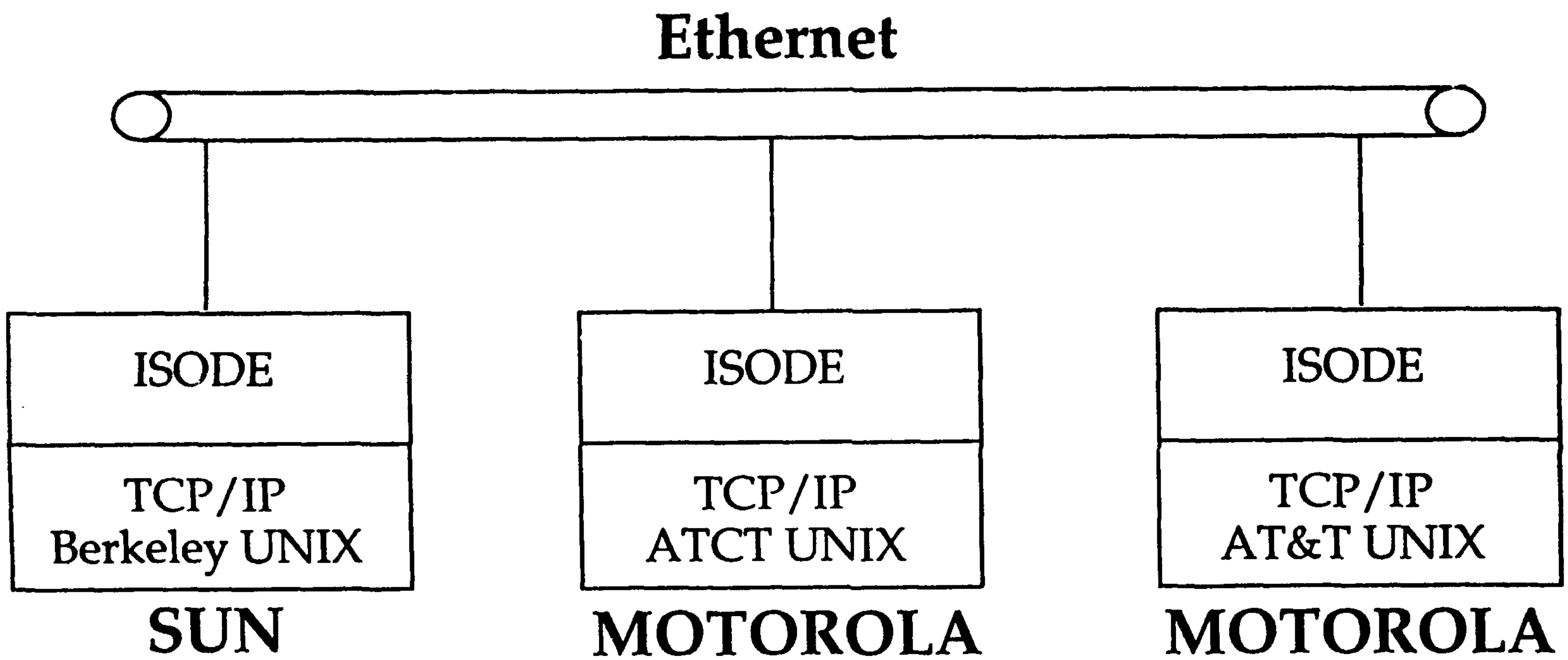
  - Layer 3 : Investigate Multi-casting and Intelligent Gateways
  - Layer 4 : Investigate TP4, VMTP, XTP Protocols
  - Decouple from UNIX

- Phases III and IV

  - Define Simulation Specific Services
  - Include Connectionless Services
  - Complete OSI stack portability by developing protocol stack

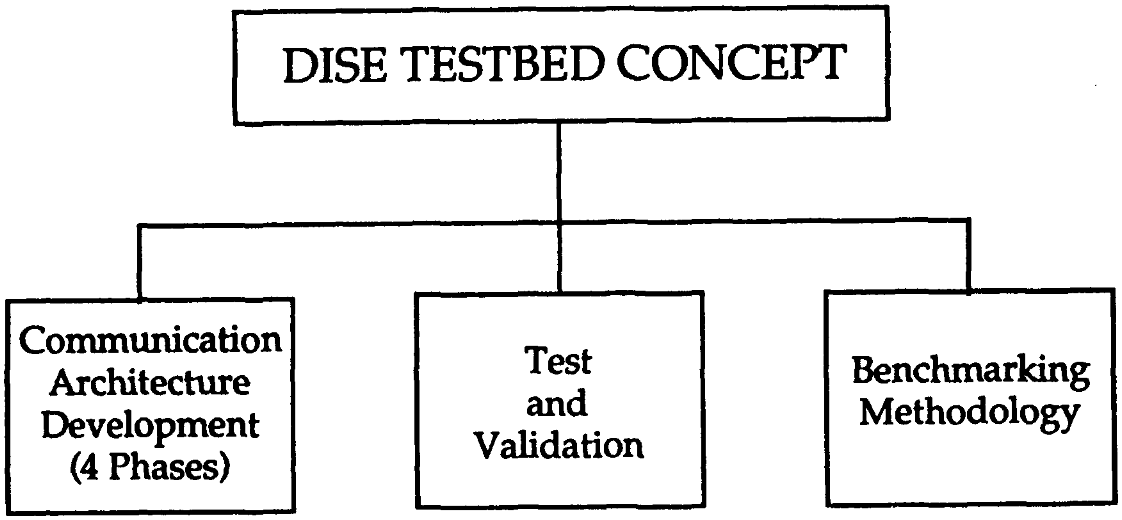
0072-1045

CURRENT STACK ENVIRONMENT (IST)



- Application Services implemented thru ISODE
- Data transmission performed using Remote Operations (ROSE)
- Connection - Oriented Services (ACSE)
- Send packets across Ethernet between any two of three machines

0072-1046



Objective: To present a concept/implementation scheme for a networked, data communications testbed environment using general-purpose protocols.

- Plug prototype protocol into layer
- Perform tests with stack

0072-1047

SUMMARY

Current

- Ported ISODE to SUN and Motorola VME machines
- Studying ISODE Application Services and documentation
- Sending packets through quasi-OSI stack between two of three computers

Future

- Multiconnection capability
- Investigate Transport layer protocols (VMTP, XTP, TP4)
- Investigate OSI capabilities for multicasting operations over long-haul networks.

0072-1048

Results of DARPA WAREX 3/90 and BFIT Exercises March and April, 1990

Steven Blumenthal
BBN Systems and Technologies
A Division of Bolt Beranek and Newman Inc.

Presented at:
Third Workshop on Standards for the Interoperability of Defense Simulations
Orlando, FL
August 7-8, 1990

WAREX 03/90 Army Objectives

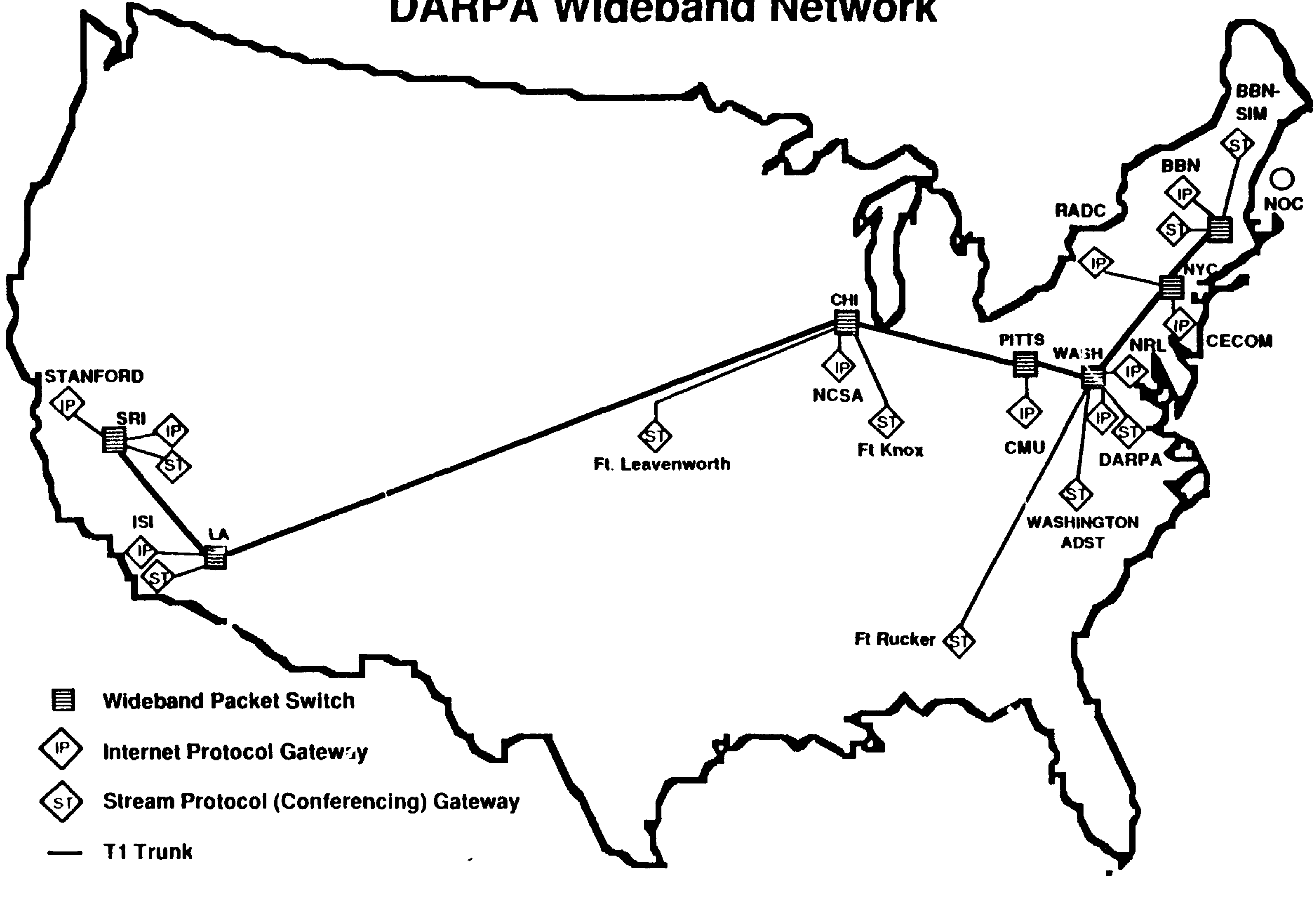
- To confirm suitability of SIMNET Semi–Automated Forces to meet Army Close Combat Tactical Trainer training requirements

- To meet 1st Infantry Division training requirements

- To demonstrate the potential of SIMNET Semi–Automated Forces to expand simulation to Advanced Battle Simulation of Battlefield Operating Systems to Corps / Combined Arms Army level in a phased program

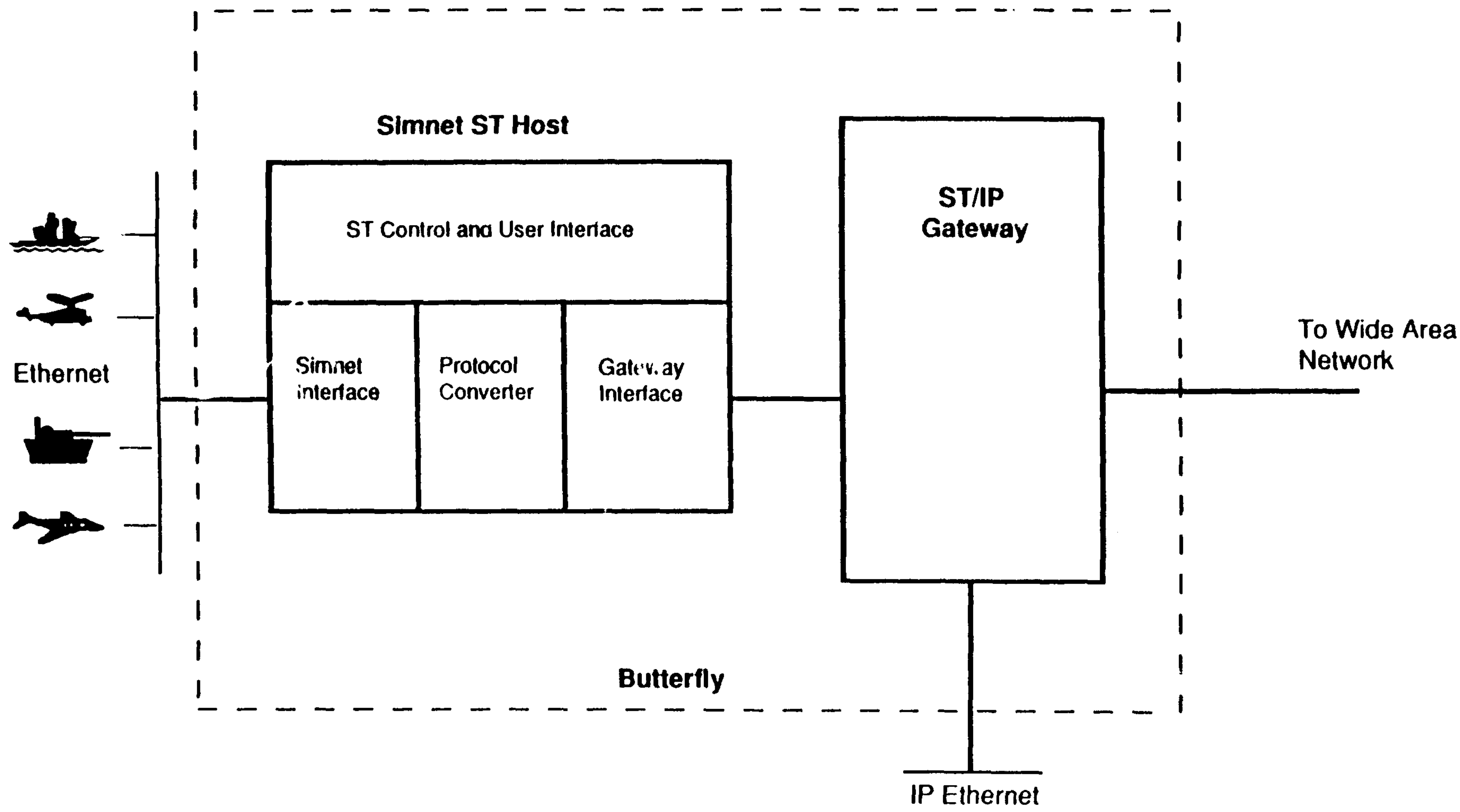
- To coordinate training at multiple locations

DARPA Wideband Network



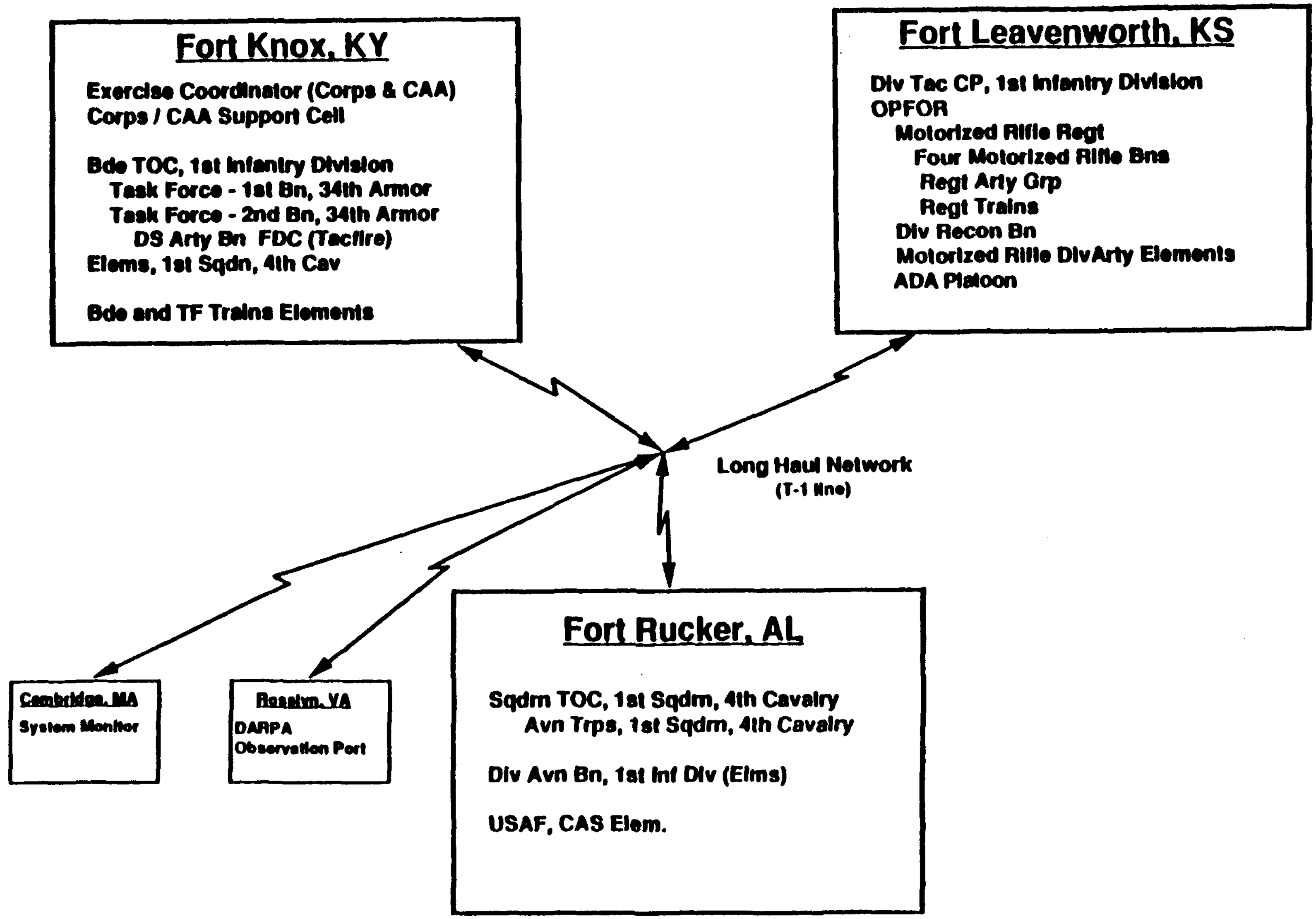
BBN Systems and Technologies

WAREX 3/S WAN Gateway



BBN Systems and Technologies

WAREX 03/90 Network Layout



WAREX 3/90 Demonstration

- Vehicles distributed across 5 sites
- Vechicle types include:
  - Semi-Automated Forces (SAF)
  - Helicopters
  - Fixed Wing Aircraft
  - Support Vehicles
- Other traffic:
  - packet voice - 10 channels @ 16Kb/s per channel

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WAREX 3/90 Demonstration (Cont.)

- Vechicles seen in last engagement

- Simulators and SAF:

728	Tanks	(M1, M2, T72, BMP2)
86	ADATS	(ADATS, ZSU23)
63	Helicopters	(AH64 Apache, OH58 Scout, Mi24, Mi28)
1	Fixed Wing Aircraft	(A10)
188	Missiles	(TOW, Others)

1066	Total Simulators and SAF	

- Support Vehicles:

271	Artillery	(M106A1, M109, 2S1, M1943)
167	Supply Trucks	(M35A2, M977, M978, UR375C, UR375F, GAZ66)
8	Command Ppsts	(M577)

446	Total Support Vehicles	

- Total Vehicles: 1512

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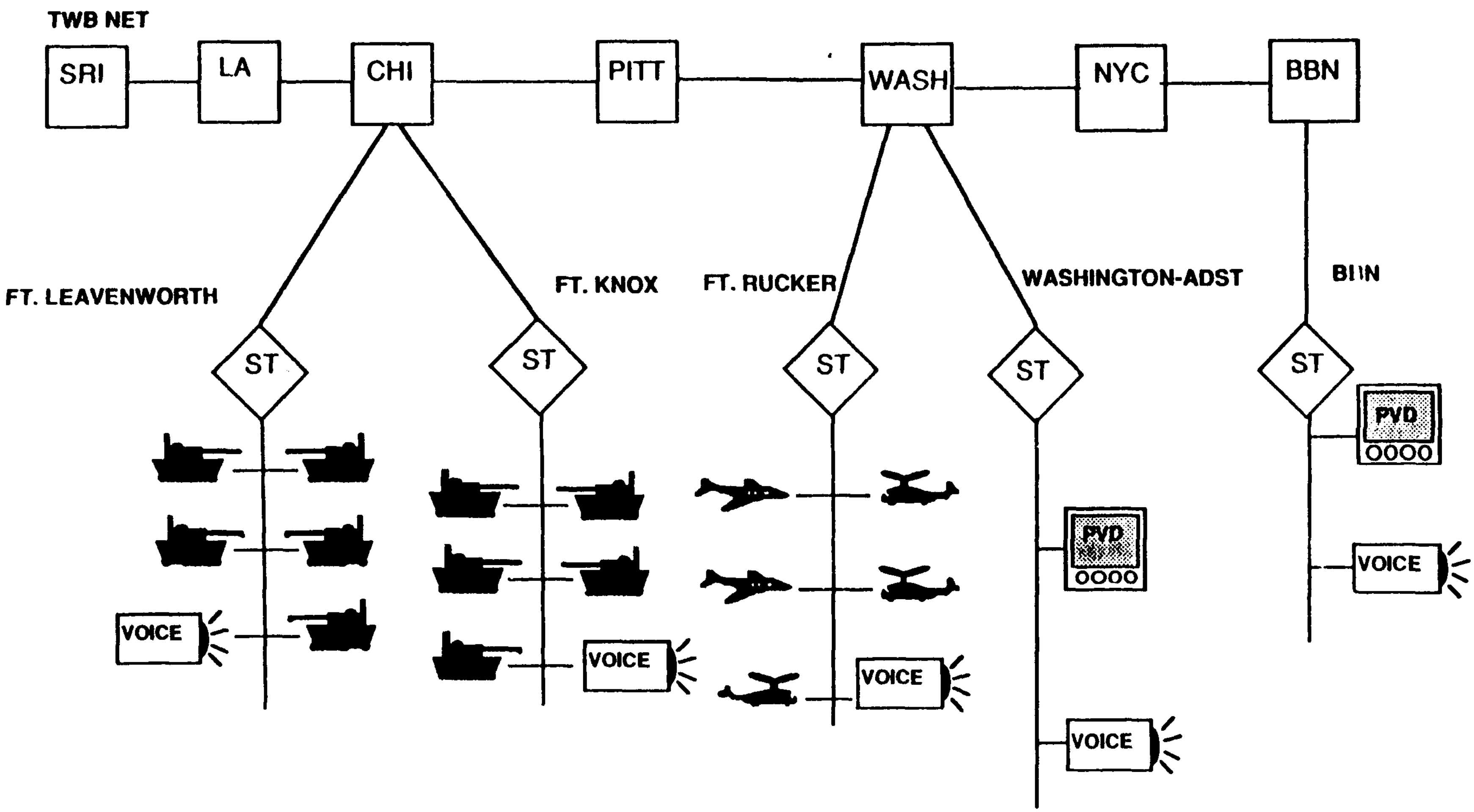
WAREX 3-90 SITE CONFIGURATION



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Navy Battle Force Inport Training (BFIT) - DARPA SIMNET Proof of Principle Demonstration

Goals:

- Application of Distributed Processing to Navy Trainiing
- 4 Independent Sites (LANs) Internetted Via WAN
- Joint Interoperable Training Environmment
- Navy Trainer Integration Using SIMNET (ADST) Technologies
  - TACDEW FCTCLANT
  - MILSPEC Combat Systems Mock-Up at FCTCLANT
  - CSTS FCTCLANT
  - Fixed-wing and Rotary A/C simulation - Marines at Ft. Rucker
  - ADST/Army Tank Simulations at Ft. Knox
  - FDDS at FCTCLANT
  - JOTS LHD-1 NORVA
  - Combat Systems LHD-1 NORVA
  - ADST/Semi-Automated Forces Ft. Knox

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BFIT / SIMNET Demonstration Sites

- Ft. Knox, KY
  - Manned Tank Simulators
  - 7 Companies Semi-Automated Forces (SAF)
  - 5 Fixed Installations (BFIT Targets)
  - 7 Voice Channels
- Ft. Rucker, AL
  - Manned Helicopter Simulators
  - 7 Voice Channels
- Washington ADST, Arlington, VA
  - Observer Site
  - 7 Voice Channels
- FCTCLANT, Dam Neck, VA
  - ETA BFIT-SIMNET System Interface
  - USS WASP Combat Simulation Training System (Docked at Norfolk)
  - 3 BFIT Ship Simulators
  - 4 Voice Channels

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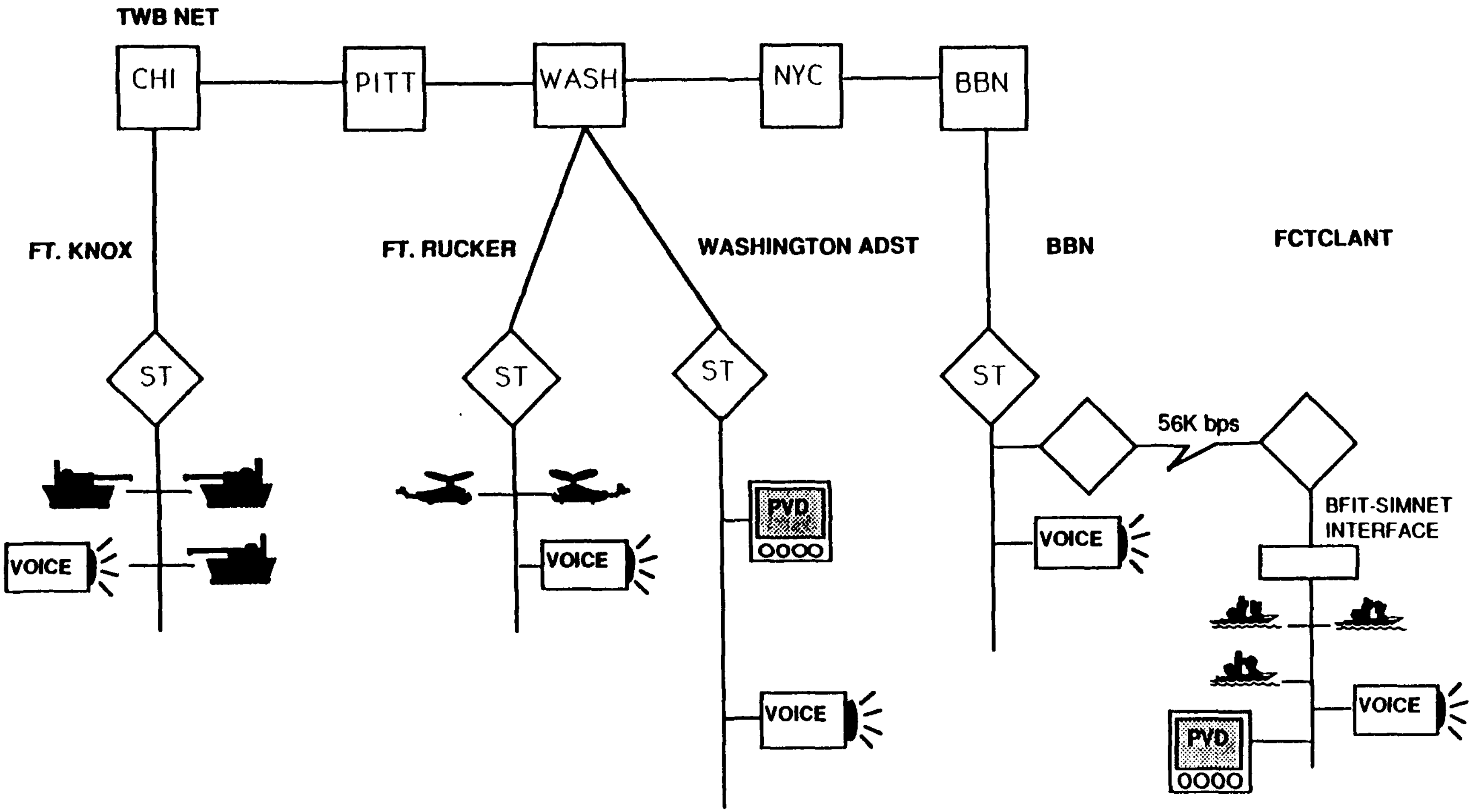
BFIT SITE CONFIGURATION



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BFIT / SIMNET Demonstration Results

- Interoperability between BFIT and SIMNET Simulators
- Navy/Marines Joint Exercise
- Internetworking of sites via TWBNet

ISSUES FROM POSITION PAPERS

Note: Due to time limitations, these issues were not explicitly discussed in the meeting. Some of these issues were covered in the Required Network Services discussion.

Communications Architecture Subgroup

Questions and Issues

1. Communication Requirements:

   Communication requirements of the DIS application should be specified (Network management functions should also be specified). Should these requirements be specified in the current standard? If so, how should they be stated?

2. PDU Size:

   What should the maximum PDU size be?

3. Site, Host, Identification:

   How are Identification numbers to be assigned? Are they permanently assigned or assigned at the start of each exercise? Who assigns the numbers?

4. TADIL-J/JTIDS?Link-16:

Should these models be adhered to? How do these models affect the current standard? Future standard work?

5. Network Traffic:

What kinds of recommendation can be made to reduce the number of messages that need to be issued to accomplish the goals of DIS?

6. Priority and Security:

Fields representing the priority and security level of a PDU are going to be added to the PDU header. Does the communications architecture group have any recommendations concerning how th'^ should be accomplished?