A COMMUNICATION SYSTEM ARCHITECTURE FOR INTEROPERABLE SYSTEMS

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ABSTRACT

This paper describes a Worldwide Digital System Architecture that was developed in response to tasking from the Office of the Secretary of Defense to the Defense Communications Agency (DCA). This tasking directed DCA to develop a Worldwide Digital System Architecture in coordination with the Military Departments, the TRI-TAC office, and other interested agencies and commands. The main purpose for developing this architecture is to take a first step toward assuring that the many command and control communications and information processing systems are sufficiently interoperable in order to achieve needed survivability and endurability.

INTRODUCTION

The Worldwide Digital System Architecture (WWDSA) summarized in this paper outlines a plan for achieving a survivable and endurable endurable capability that synergistically combines elements from the communications systems supporting the U.S. DoD Tactical, Civil, and NATO communities. This survivable and endurable capability also includes significant improvements in security, performance, interoperability, and provides new services to a wide community of users. Addressing the combined capabilities of many individual systems within a common overall architecture is a step towards assuring that users in one community can communicate with similarly equipped users in other communities.

The WWDSA architecture is the result of an extensive process that began with and was driven by user requirements. The user requirements used to develop the architecture are qualitative and address the type of communications services, the quality of the communication services and the needed fundamental connectivity of subscribers and/or systems. Needed systems improvements to achieve the system performance to meet the qualitative user requirements were obtained by first developing a baseline description of

DoD telecommunications systems, and second by comparing the required capabilities With those that could be achieved by the baseline. In order to develop reasonable alternative architectures, evaluation criteria and methodology were developed that were used to assess performance, survivability, relative cost, and transition capability. Based upon these evaluation criteria, several alternative architectures were developed and assessed (1).

The central thrust of the entire WWDSA effort was to develop an architecture that will satisfy as many of the realistic needs of the users as possible, "backing off" only as necessary for reasons of technology, implementation, and cost. A recommended goal architecture was chosen based upon the evaluation of alternatives. The specific attributes of this chosen goal architecture were further developed and a transition strategy to achieve the required system attributes has been formulated.

WWDSA REQUIREMENTS

In the development of the WWDSA architecture, emphasis was placed on the requirements of the Worldwide Military Command and Control System (WWMCCS) and the Commanders in Chief (CINCs), although the requirements of the Military Departments, DoD agencies and certain civil organizations were also given strong consideration. Qualitative user requirements established the range of alternative WWDSA architectures that should be considered, whereas the cost of satisfying these requirements is an essential input to the requirements validation process.

WWDSA user requirements were developed through a Combination of: (1) analysis of the missions and operational concepts of the various users, (2) examination of applicable policy statements, (3) forecasts of technological advances, (4) extrapolations of usage trends for existing services, and (5) forecasts of demands for new services. The user organizations played an important role in the requirements development process through a working group[*] that developed the WWDSA by providing inputs regarding their missions, operational concepts and required connectivities, and providing timely criticism of strawman qualitative requirements developed by DCA. Several iterations of user requirements postulation and critical review were conducted before the user requirements were finalized.

SELECTED WWDSA CAPABILITIES

Eight alternative architectures were evaluated as well as the baseline using an extensive and formal evaluation criteria. The selected WWDSA goal architecture can be summarily

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[*] This Working Group consisted of representatives from the Military Departments, the TRI-TAC office, and several other interested agencies.

described by its key features. These WWDSA goal architecture key features are:

a) Access to many sources of connectivity, including a variety of transmission media for path diversity.

b) Ability to use these resources intelligently through improved routing strategies, processor augmentation and extension of system capabilities to the access node level when needed.

c) Modularly expandable switches that allow low start-up costs.

d) Interconnected voice and data networks for mutual support and improved survivability.

e) Improved system control employed among flexible Nodes to improve call connect performance and system control responsiveness (Distributed and secure CCS is an important part of this feature).

f) Tandem Switching between designated flexible Nodes at the access level to improve connectivity, provide a more distributed structure, and thereby increase survivability and responsiveness.

g) Multirate capability (16 and 64 kbps) among flexible Nodes for more efficient use of digital transmission links and improved survivability of secure voice users (secure voice at 2.4 kbps will be carried through the circuit switched network via 16 and 64 kbps channels).

h) Enhanced 2.4 kbps secure voice survivability through the use of packetized voice and interconnection between circuit- and packet-switched networks.

i) The incorporation of a high (toll) quality 16 kbps secure voice algorithm with good tandeming and conferencing characteristics.

j) Expanded and integrated use of communication satellites interfaced via small satellite earth terminals, both military and commercial, to supply wideband services and expanding the mix of media available to the flexible Nodes.

k) Improved internetwork system control between DCS, tactical, and commercial networks through the use of automated aids (network Status indicators, facility reassignment algorithms, and data bases) useful to network management decision makers. (System control capabilities are at the locations of critical users to assist in the step-by-step restoral of a disconnected network from the “bottom-up.”)

l) Encourage common standards for all networks, where feasible, for improved interoperability.

A pervasive theme inherent in these features is the emphasis on promoting distributed interoperable network configurations for improved survivability, and transmission efficiency. Current DoD telecommunications and commercial development projects emphasize digital implementation of analog functions (switching, transmission, speech processing). The emphasis in the future will be to exploit emerging information processing and storage capabilities to provide better system control and network management, use of multiple resources, and interoperable configurations of both packet-switched and circuit-switched networks. Figure 1 is a functional diagram that illustrates the above listed features of the WWDSA goal architecture.

TRANSITION STRATEGY

The transition strategy for achieving the WWDSA goal architecture attributes is an evolutionary strategy that maintains system performance and the availability of current services as survivability is enhanced and needed new services are added. The WWDSA goal architecture is compatible with, and takes advantage of, commercial capabilities. Further, both fixed and tactical U.S. government systems will move toward the goal architecture at rates which vary according to their current state of development, budgeting, etc. Allied systems are expected to adopt many of the same features as the WWDSA because they offer many advantages, including interoperability enhancement.

Figure 2 graphically illustrates the stages of evolution of the various commercial carriers, U.S. government (both civilian and military) and Allied networks (i.e., NATO).

The key objectives of the transition strategy include:

a) A transition by evolution.

b) Emphasis on funded on-going system upgrades that are compatible with the WWDSA goal architecture.

c) Flexibility in implementation of features so that unexpected redirection of programs will have minimal impact on overall budgeting and completion milestones.

d) Ability to implement new services on a timely basis and to react to priorities as needs become identified.

e) Minimization of disruption of service or degradation of performance during transition.

f) Avoidance of major perturbations in the funding levels required year by year.

CONCLUSIONS

The conclusions of the WWDSA working group that are based upon the overall WWDSA effort are as follows:

a) The users need to continue to play an important role in the development of the WWDSA goal architecture and specifically in the further definition of the capabilities described by this architecture. They should be aware of compromises in capability that are required due to implementation difficulties.

b) The WWDSA goal architecture should be officially adopted as the goal for the evolution of all telecommunications systems that fall under the scope of WWDSA. Certain systems such as the DCS should be able to achieve this goal by 1995, while others may require a longer transitioning period. The WWDSA goal architecture is as responsive as possible to the users' stated needs, considering implementation factors.

c) Policy should be promulgated requiring that all proposals for new programs or redirections of existing programs for telecommunications systems be reviewed in the light of whether their end capabilities will be in consonance with the WWDSA goal architecture. Interoperability between networks should be a key decision factor.

d) Research and Development (R&D) efforts should be initiated on a timely basis to ensure that the postulated capabilities of the WWDSA goal architecture can in fact be implemented by 1995. Technical areas requiring new R&D initiatives include the following:

- Common Channel Signalling (CCS) to all backbone and access switches
- Improved 16 kbps secure voice algorithm
- System control for inter-network management
- Enhanced EHF satellite
- Voice and data network interconnection
- Packetized voice at 2.4 kbps
- Standardization across networks

REFERENCES

1. Choisser, Robert, "On Application of Decision Analysis to the Selection of a Telecommunications Architecture," NTC Proceeding, November 1981.

WORLDWIDE DIGITAL SYSTEM ARCHITECTURE

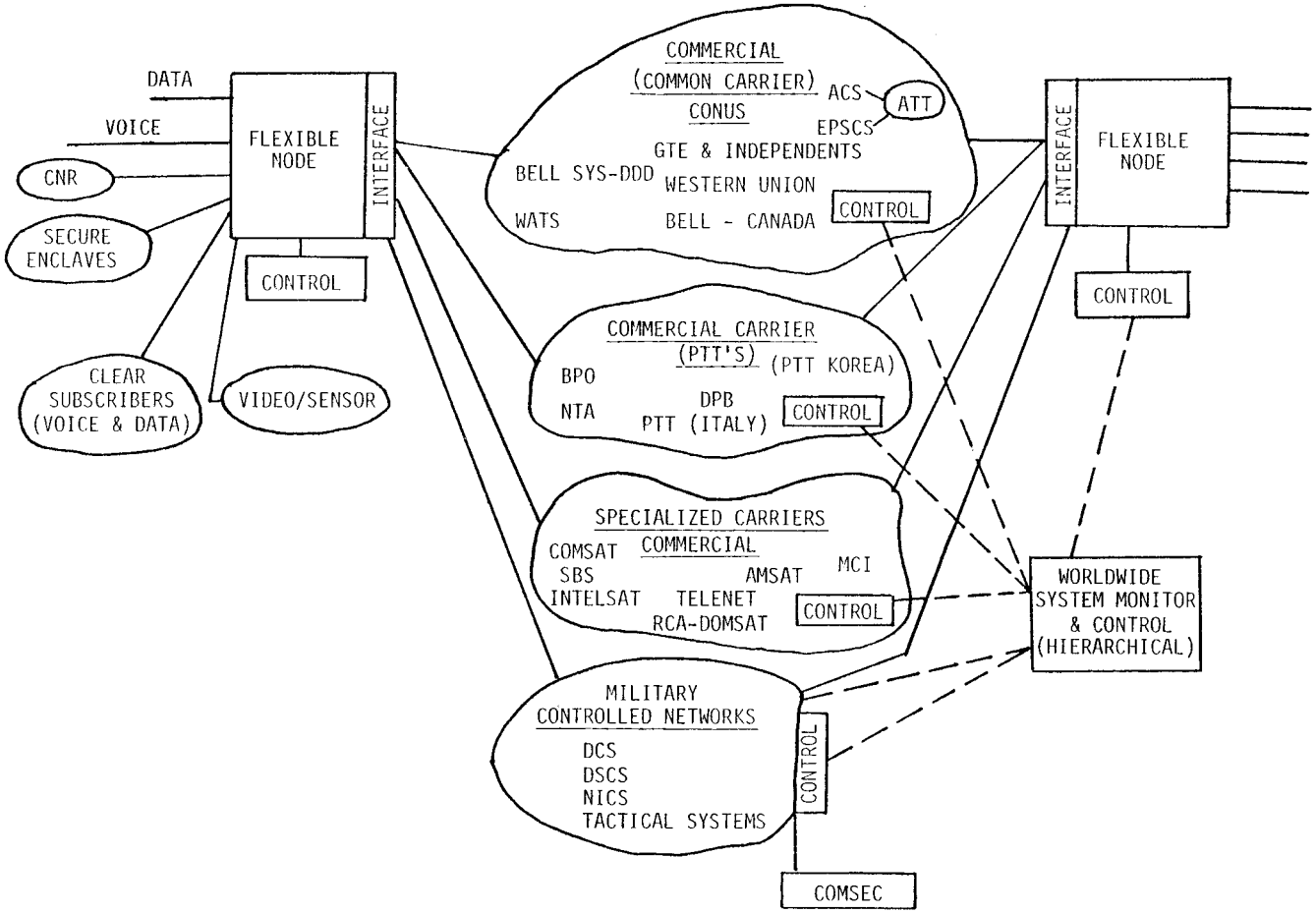

Figure 1

WWDSA EVOLUTION AND SYSTEM RELATIONSHIPS

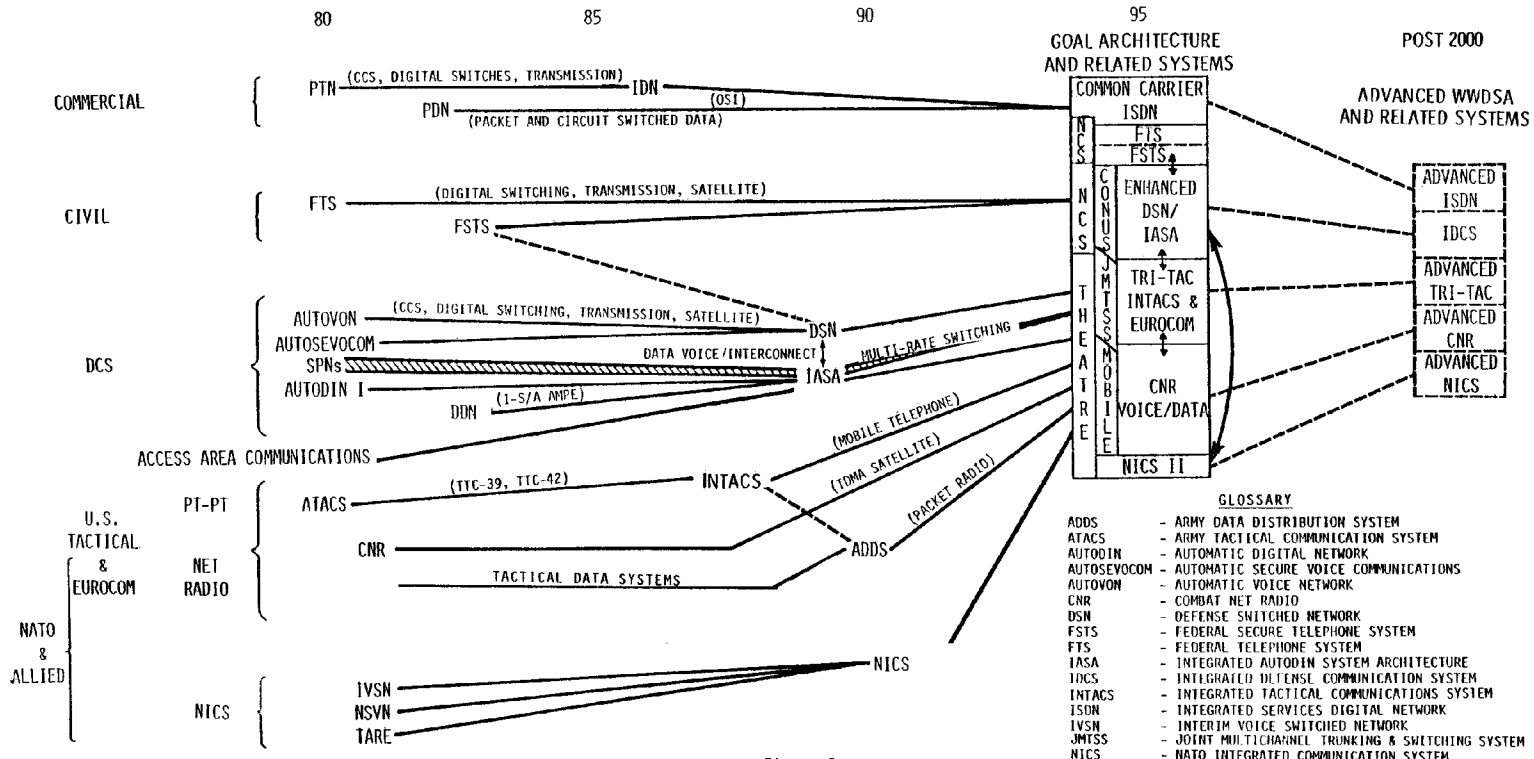

Figure 2

GLOSSARY

ADDS	- ARMY DATA DISTRIBUTION SYSTEM
ATACS	- ARMY TACTICAL COMMUNICATION SYSTEM
AUTODIN	- AUTOMATIC DIGITAL NETWORK
AUTOSEVOCOM	- AUTOMATIC SECURE VOICE COMMUNICATIONS
AUTOVON	- AUTOMATIC VOICE NETWORK
CNR	- COMBAT NET RADIO
DSN	- DEFENSE SWITCHED NETWORK
FSTS	- FEDERAL SECURE TELEPHONE SYSTEM
FTS	- FEDERAL TELEPHONE SYSTEM
IASA	- INTEGRATED AUTODIN SYSTEM ARCHITECTURE
IDCS	- INTEGRATED DEFENSE COMMUNICATION SYSTEM
INTACS	- INTEGRATED TACTICAL COMMUNICATIONS SYSTEM
ISDN	- INTEGRATED SERVICES DIGITAL NETWORK
IVSN	- INTERIM VOICE SWITCHED NETWORK
JMTSS	- JOINT MULTICHANNEL TRUNKING & SWITCHING SYSTEM
NICS	- NATO INTEGRATED COMMUNICATION SYSTEM
NVSN	- NATO SECURE VOICE NETWORK
PDN	- PUBLIC DATA NETWORK
PTN	- PUBLIC TELEPHONE NETWORK
TARE	- TELEGRAPH AUTOMATIC RELAY EXCHANGE
TRI-TAC	- TRI SERVICE TACTICAL COMMUNICATIONS
TTC-39	- TRI-TAC CIRCUIT SWITCH
TTC-42	- TRI-TAC MESSAGE SWITCH