# DISTRIBUTED COMPUTER TAXONOMY

## BASED ON O/S STRUCTURE

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Abstract

The taxonomy considers the resource structure at the operating system level. It compares a communication based taxonomy with the new taxonomy to illustrate how the latter does a better job when related to the client's view of the distributed computer. The results illustrate the fundamental features and what is required to construct fully distributed processing systems (network computer, "cooperative" autonomy, and decentralized computers).

The talk then discusses the problem of network computers for space station noting that the evolution from computer network operating systems to network computer operating systems is not practical (almost infeasible). The research direction is then discussed with the NASA research into network computers being listed.

## DISTRIBUTED COMPUTER TAXONOMY
## BASED ON O/S STRUCTURE

- COMPARE SIMILAR TAXONOMIES

  COMMUNICATIONS VS. O/S

- PROBLEM WITH NETWORK COMPUTER O/S

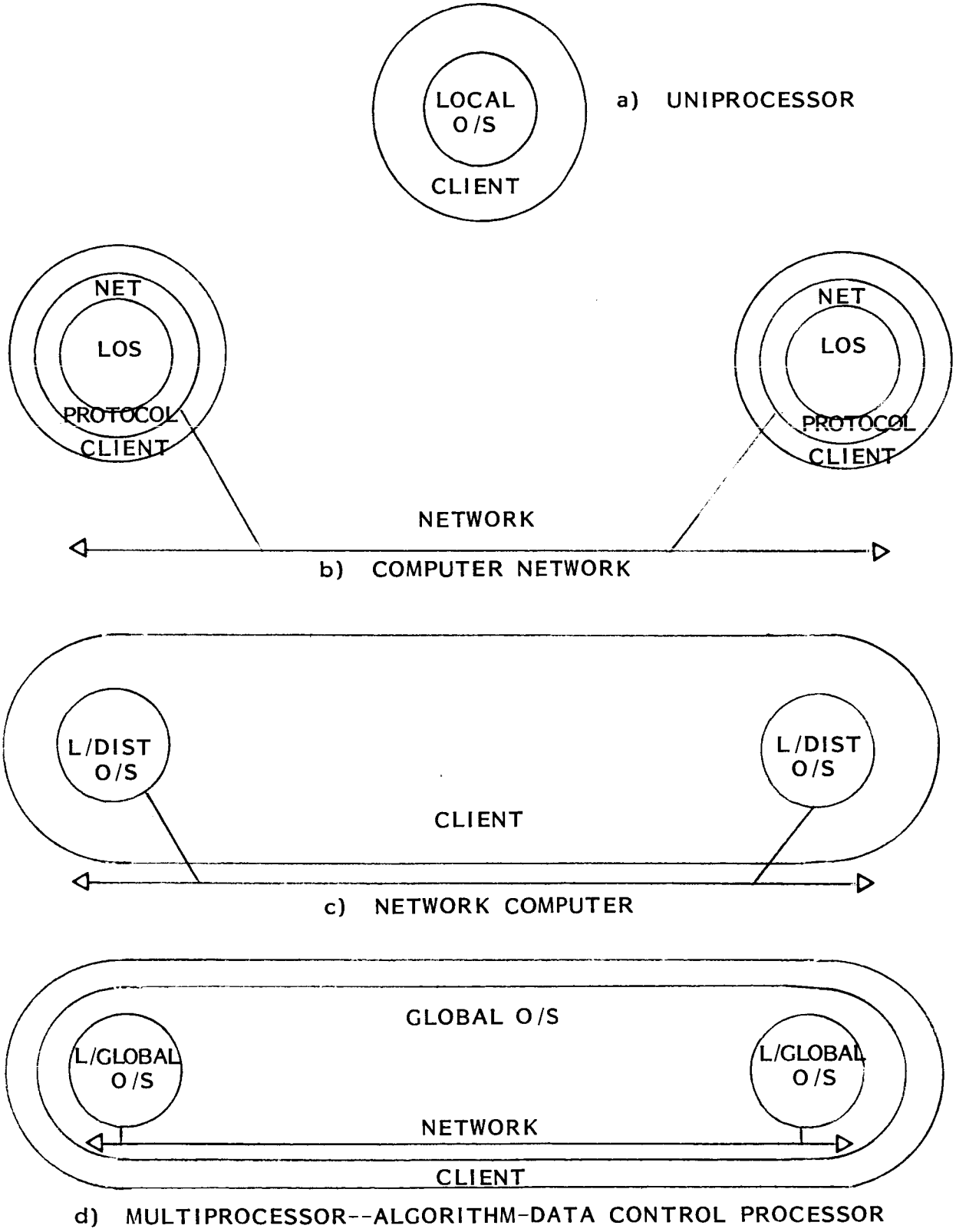
  APPLICATION TO SPACE STATION

- RESEARCH SUPPORTIVE NETWORK COMPUTER O/S

O/S OBJECTIVE: CREATE/CONTROL RESOURCES

EFFICIENTLY SHARE RESOURCES AMONG SET OF USERS

## DISTRIBUTED COMPUTER DIVISIONS



## NEW TAXONOMY FEATURES

- BETTER REPRESENTATION OF CLIENT'S VIEW

- DISTRIBUTED SYSTEM DISTINCTION

  COMPUTER NET. - LOCAL CONTROL EXCEPT COMM.
  COMM. RESOURCE VALUE-ADDED

  NETWORK COMP. - INTEGRATED LOCAL - NETWORK - DIST. CONTROL IN KERNEL

- ADMIT. SEPARATE CLIENT BUILT RESOURCE

  OK, BUT LIMITED

  DIFFICULT SHARING - INTEGRATING IN O/S

- INDICATES CRITICAL RESEARCH FOR NETWORK O/S

  BETTER HARDWARE - FIRMWARE - O/S KERNEL

  DISTRIBUTED CONTROL SUPPORT

## DISTILLING THE QUOTATIONS

- CAREFUL ~~MAY NOT~~ BE A ROAD FROM COMP. NETWORK (LOS+NET.) TO NETWORK COMPUTER (LDOS)

  NO ROAD - (NEW TAXONOMY)

- NEW FEATURES NEED NEW METHODS

- EMBEDDED O/S COMPLEX--SELECT WITH CARE - FOUNDATION OF SYSTEM

  O/S NASTY HABIT OF GETTING FIXED IN CONCRETE

- COMPUTER NETWORK MODEL NOT APPROPRIATE FOR SPACE STATION

## TAXONOMY - COMMUNICATIONS
(WITTIE & VAN TILBORG)

| SEPARATION | FEATURE - USE | | EXAMPLE |
|---|---|---|---|
| | **COMPUTER NETWORK** | | |
| LARGE-MED.<br>LOOSELY COUPLED | LOCAL-NODE AUTONOMY<br>SIMPLE MESSAGES | REMOTE TERMINAL<br>ACCESS RESOURCES | MULTI-PORT<br>ARPANET, GRAPE-VINE, ETC. |
| | **NETWORK COMPUTER** | | |
| MID-SMALL (LAN)<br>CLOSELY COUPLED | LOCAL-GLOBAL CONTROL<br>COMPLEX MESSAGES | DIST. RESOURCES<br>NET. TRANSPARENCY<br>RELIABILITY | OFFICE AUTOMATION<br>FDPS, ARCHONS, CLOUDS<br>FUTURE COMPUTERS |
| | **MULTIPROCESSOR** | | |
| SHARED MEM.<br>TIGHTLY COUPLED | GLOBAL CONTROL<br>MACHINE LEVEL MESSAGES | TRANS. RESOURCES<br>DISTRIBUTED TASKING<br>RELIABILITY | CM*, APOLLO<br>TANDEM, SYNAPSE, SEQUOIA, ETC.<br>FUTURE COMPUTERS |

## TAXONOMY - O/S CONTROL STRUCTURE

| O/S CONTROL LOCATION | FEATURE - USE | | EXAMPLE |
|---|---|---|---|
| | **UNIPROCESSOR** | | |
| LOCAL TO CPU | COMPLEX AUTONOMY | MULTI-USER MULTI-TASKING | MANY APOLLO, SEQUOIA, ETC. |
| | **COMPUTER NETWORK** | | |
| LOCAL + NETWORK | LOCAL-NODE AUTONOMY VALUE-ADDED COMM. | REMOTE TERM ACCESSED RESOURCES | MULTI-PORT ARPANET, X. PARC. OFFICE AUTOMATION CM*-STAROS, ETC. |
| | | DIST. DATABASE (CLIENT) | ROE, TABS, LOCUS, ETC. |
| | **NETWORK COMPUTER** | | |
| LOCAL-NETWORK-DISTRIBUTED | LOCAL OR LOCAL-GLOBAL OR GLOBAL CONTROL | SHARED RESOURCES | NONE IN EXIST. |
| | | NETWORK TRANS. | FDPS (CLOUDS) DEC. COM. (ARCHONS) |
| | | RELIABILITY | PROCESS CONTROL, SPACE STATION |
| | **ALGORITHM - DATA CONTROL COMPUTER** | | |
| LOCAL-(NETWORK) + SPEC. OP. + SPEC. DATA CTRL. | LOCAL AUTONOMY SPEC. CONTROL | PARTICULAR PROB. OR EQUATION | STAR, FEM, MPP, MANY |

## THE NETWORK COMPUTER PROBLEM - SPACE STATION

"Evolution is generally appropriate as the primary mode of computer (and other) system development, but it should be performed with much careful thought. Almost all work on "distributed" systems in general and "distributed"/network operating systems in particular has been evolutionary to an extreme--most of the resource management concepts have been simple adaptations of centralized ones, burdened by inappropriate and even counter-productive artifacts. The ineffectiveness of constructing airplanes which fly by flapping their wings was recognized early; but corresponding realizations about distributed systems have largely not taken place yet, as we have argued for several years." (Jensen - CMU - 84).

"Many claims have been made for distributed systems. Among them are improved reliability, increased processing power, and more flexible user environment. It is not clear, however, that current technology is able to realize these advantages. Without advances in methodologies for constructing distributed systems, we are faced with a situation in which we are likely to see less, not more, improvements in these areas, ... difficulties ... also results from increased complexity of managing the distributed environment." (McKendry - Georgia Tech - 83).



"Support for coordinated distributed computing, as exemplified by decentralized computing, network computers, or "cooperative" autonomy is critical to the development and use of embedded system when implemented over a network of computers." - "Future aerospace vehicles, like the Space Station, which must support autonomous, real-time subsystems, coordinated experiments including robotics and AI, and extensibility as new capability is added, will demand the best in operating system methodology. It is clear that without advances in distributed operating system methodologies" - this support is - "not going to be realized." (Foudriat - LaRC - 84).

To envision the Space Station Computer System Network as a <u>data</u> management problem with the addition of some "standard" networking protocols is a serious error. To concern one's self with bandwidth, network protocol and transfer of uninterpreted data, etc. is naive, at best. Once this computer system is conceived as an extremely complex <u>resource</u> management and sharing problem, progress on its development will have begun. (Foudriat - LaRC - since 1981).

# OBJECT BASED O/S

OBJECT - ENCAPSULATION OF INFORMATION
SPECIFIC MECHANISMS FOR USE (ACCESS, ETC.)

SYNONYMS - PACKAGE (ADA), MODULE (MODULA - 2)
GUARDIAN (CLU), OBJECT (PATH PASCAL)

- O/S PARADIGM OF 80s-90s - LIKE VMS-DOS (70s)
  UNIX FILE, C (80s)
- OBJECT (NESTED) FOR EACH RESOURCE
- FEASIBLE FOR EMBEDDED SYSTEMS (FOUDRIAT - 84-85)

RESEARCH

- STRUCTURE FOR DISTRIBUTED CONTROL
- UNDERLYING COMPUTER SUPPORT
  (HARDWARE-FIRMWARE-O/S KERNEL-O/S LANGUAGE)
- PERFORMANCE TRADES
- DEBUG SUPPORT FOR DEVELOPMENT & TEST

## NETWORK COMPUTER RESEARCH

- GREAT DEAL OF RELATED DISTRIBUTED DATABASE WORK

- ARCHONS - CMU $\approx$ $2-3 M/YEAR AF, NAVY, IBM, OTHERS

- NASA (505-37-03)

| INSTALLATION | NETWORK | LANGUAGE | OBJECTIVE |
|---|---|---|---|
| SUNY-STONY BROOK | MICROJET | MODULA-2 | LARGE ($100-10^3$) DEBUG TECH. |
| GA. TECH. | CLOUDS | C | TRANSACTION IN KERNEL O/S LANG. |
| UNIV. OF ILL. | EMBEDDED O/S | PATH PASCAL, C, UNIX/ UNITED | EMBEDDED PERFORMANCE |
| UNIV. OF SO. FLA. | RDML | CONC. PASCAL & OTHERS | RELIABLE DISTRIBUTION |
| LARC | SDL-NET | PATH PASCAL | PERF. NET TOPOLOGY |

MANY (AEROSPACE, IND, UN. GOVERN.) C.S. PROFESSIONALS (& LAITY) DO NOT UNDERSTAND THE SUBTLE NATURE OF THE DIST. O/S PROBLEM.