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A MULTI-COMPUTER SYSTEM WITH A FLEXIBLE TOOL FOR EFFICIENT TRAFFIC MANAGEMENT

SUMMARY

In recent years, several computer models have been developed to help traffic engineers understand and solve traffic problems. Although traffic engineering studies continue to be carried out by manual methods, computer approaches are being increasingly employed for traffic engineering analyses and design. Many authors have described the most common computer programs for signal timing optimization and traffic simulation flows.

The volume of traffic is increasing all the time. It is happening so fast that the space available for new roads and car parks cannot grow apace enough. That would mean too great a strain on humans and the environment. This paper describes a multi-computer system VRS 2100 with an integral part of collective traffic management.

KEY WORDS

VRS 2100 traffic computer, flexible traffic control, dynamic collective information

1. INTRODUCTION

The most common types of signals are traffic-control signals (which include pedestrian signals), beacons, and lane-use control signals. Traffic-control signals are primarily used to control the movements of vehicular and pedestrian traffic at intersections. This section describes signals at individual intersections. Signals within one-half mile of each other can be coordinated into systems to give a "green-wave effect."

Measures to restrict the flow of traffic or a deliberate reduction in the amount of space available for private cars are only a limited solution. The decisive factor for the effectiveness of urban planning and technical measures is acceptance by road users.

That requires flexible traffic control and dynamic collective information based on the latest technology. Only then can the area available for traffic be put to optimum use.

2. TECHNOLOGY THAT POINTS THE WAY

VRS 2100 is an integral part of a collective traffic management system. It permits direct influence on both private and public transport, on the basis of up-to-date information. At the same time, VRS 2100 provides cost-effective car-park management and makes collective information available to road users. Its modular hierarchical structure means that the VRS 2100 traffic computer offers not just more computing performance but also a universal range of applications and the highest possible degree of security against loss of data. The flexible hardware and software modules allow system extensions in accordance with individual needs. That is important if new information technologies are to be integrated as they become available; for example, increased networking of data bases or other sources of information. You can therefore be certain that VRS 2100 will continue to match your requirements in the future.

Standards are an important criterion in modern traffic management. They are the prerequisite for effective networking of various different users. For that reason, we have been consistent in basing the VRS 2100 design on the following standards:

- X-Windows for the man/machine interfaces
- graphic work stations with the UNIX operating system
- relational data-base management system (RDBMS) using the SQL data-base language
- VMEbus - the industry standard for real-time applications
- communications protocols such as HDLC, TCP/IP for LAN, X.25 for WAN
- a clear-cut split on the principle of "UNIX where possible, real-time where necessary".

3. THE PRINCIPLE OF DISTRIBUTED INTELLIGENCE

A multi-computer system on the principle of distributed intelligence forms the basis of the VRS 2100. That means that its functions are split between three hierarchical levels within the overall system. As a result, each level processes only the tasks for which it has been set. A further advantage is that faults or failures in individual system components can be bypassed by means of fall-back strategies, thus preventing the failure of the overall system (Figure 1).

The hierarchical levels fulfil the following functions:

- system management level
  - central operation
  - monitoring all system components
  - displaying system faults
  - logging
  - archiving
  - statistical analysis
- area level
  - communications with the components connected
  - superordinate macroscopic line and network control
  - global measurement data preparation
- intersection level
  - microscopic control (individual node)
  - safety monitoring
  - measurement data acquisition
  - local data preparation

3.1. System management level

This level is distinguished by user-friendliness and high performance. It allows the user direct access to every individual intersection and every area computer. Menu entry greatly simplifies the task of producing or altering input data and traffic program structures. In order to maintain clarity even with large quantities of data, to relieve the load on the user, and to keep reaction times to a minimum, the VRS 2100 uses graphics display techniques. For example, the operational state and the current traffic situation are displayed on a street plan and node diagrams. Operational and control states, fault messages and statistics can all be called up in graphics or tabular mode. The designers have paid particular attention to representing powerload plans, histograms, and bar charts, so as to allow unambiguous and comprehensible representations of statistical analyses. The basic data are held in the computer for as long as they are needed, and archived on long-term storage media such as optical disks.

3.2. Area level

This level is responsible for the superordinate control of several sets of traffic lights. This takes place with the aid of preset traffic program structures, taking account of current data provided by strategically significant measurement points (Figure 2). In order to be able to produce and optimize time-dependent programs, it is necessary to know precisely the traffic load at different times of day. These values are derived from continuous acquisition of measurement data, for example the time that a vehicle remains above the detector loop. The area computers collect and store values from all the intersections, at the same time converting them to indices and characteristic values.

3.3. Intersection level

The traffic lights at a given intersection can be controlled either centrally from the area computer or locally by the controller at the node itself. It the super-

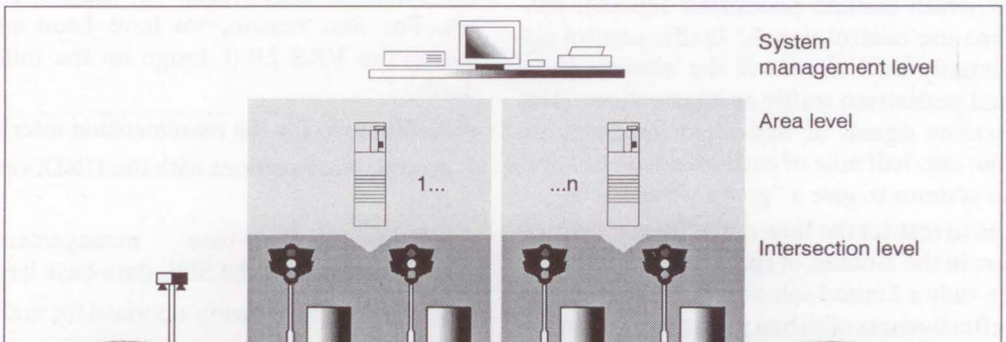

Figure 1 - Various 2100 system architecture

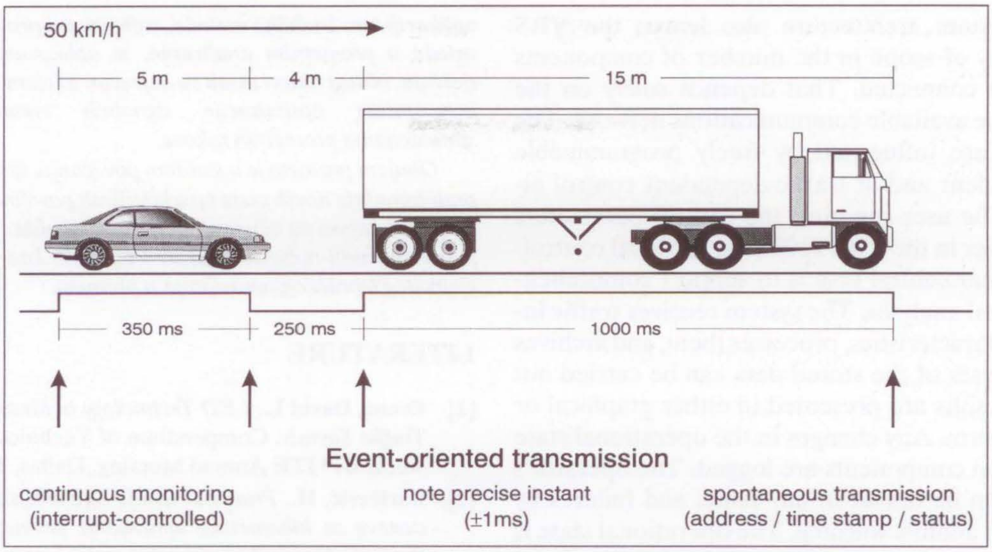

Figure 2 - Principle of event-oriented measurement processing

ordinate control fails, the local controller can take over control of the lights at the intersection. In any event, the controller is responsible for monitoring the signal states at the node; in other words, the safety aspects of the traffic lights. The detector information collected at an individual node can be transmitted to superordinate systems for further processing, or can be processed locally in the controller.

4. EFFICIENT COMMUNICATION BETWEEN LEVELS

The lines of communication between the system components (Table 1), and thus the exchange of information and commands, are those that allow the VRS 2100 to solve the tasks in hand. Unfortunately, high-quality data links are seldom available. The VRS 2100 therefore pursues a logical concept of event-oriented transmission.

That means that data for control, monitoring of functions, measurement values, and information are transmitted only when a change takes place. This makes optimum use of the resources available in the existing infrastructure. A good example of how we have made the system as powerful as necessary, but as cost-effective as possible.

5. CONCLUSION

The main functions of the VRS 2100 are: acquisition, control, logging, and providing information. In order to fulfil these tasks to best effect, the system has been designed to be independent of a particular manufacturer. It is compatible with all standard controllers, intelligent data acquisition devices (e.g. radio receivers for detecting buses), or information media. Its

Table 1. Technical data of system functions

Work-station level – HP Apollo, Series 700	
cabinet	desk-top or desk-side
performance	41 to 124 MIPS (integer arithmetic)
processor	PA-RISC
clock speed	33 to 99 MHz
main store	16 to 768 MB
hard disk	525 MB to 4 GB
networks	Ethernet, ISDN X.25, 802.5 token ring
operating system	multi-user capability
data base	relational data-base management system (RDBMS)
magneto-optical media	up to 1300 MB storage capacity
high-resolution graphics monitors	17" or 19", black & white or colour
laser printer, plotter, colour printer	

Real-time level – VMEbus industrial computer	
cabinet	19" rack
performance	27.8 MIPS (integer arithmetic)
processor	MC 68040
clock speed	25 MHz
main store	1 to 4 MB
network	Ethernet
operating system	real-time

modular system architecture also leaves the VRS 21000 plenty of scope in the number of components that can be connected. That depends solely on the quality of the available communications network. The controllers are influenced by freely programmable time-dependent and/or traffic-dependent control algorithms. The user can alter the control parameters on-line, either in the VRS 2100 or in the local controllers. A further central task is to support comprehensive statistical analyses. The system receives traffic indices and characteristics, processes them, and archives them. Analyses of the stored data can be carried out later; the results are presented in either graphical or numerical form. Any changes in the operational state of the system components are logged. The operator's attention can be drawn to any faults and failures by means of an audible warning. The operational state is displayed in both the graphics shell and the detail screens. All the functions described above can of course also be configured to the user's specific system requirements.

SAŽETAK

VIŠE-RAČUNALNI SUSTAV S FLEKSIBILNIM ALATOM ZA EFIKASNO UPRAVLJANJE PROMETOM

U posljednje vrijeme pojedini su računalni modeli razvijeni za podršku prometnim inženjerima u rješavanju problema u prometu. Iako prometno inženjerstvo ima kontinuitet u aplikaciji tzv. "ručnih" metoda, sofisticirani pristup sve se više ogleda u prometnim analizama, te oblikovanju prometnih rješenja. Mnogi autori pisali su najvećim dijelom o računalnim programima optimizacije signalnih vremena, te o simulacijama prometnih tokova.

Obujam prometa je u stalnom povećanju, tako da ga jedva prati izgradnja novih cesta i parkirališnih površina. Također su izraženi i napori za očuvanje čovjekova okoliša. U ovom radu je opisan multi-računalni sustav VRS 2100 kao integralni dio cjelovitog tehničkog upravljanja u prometu.

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