Transputers and MS-Windows - Case Study of a Development Process.

Øyvind Teig, Autronica, Trondheim and
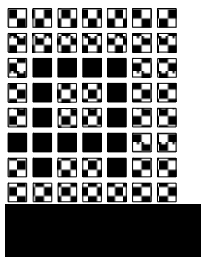Thor Vollset, Tordivel, Oslo

AUTRONICA A/S

"Autronica protects property, life and environment."

- Founded in 1957.
- Headquarter in Trondheim.
- 500 employees.

Product range:
- Fire detection systems.
- Smoke detectors.
- Monitoring of fluid level
- Pressure and temperature sensors.
- Maritime Electronics.

MIP- Calculator

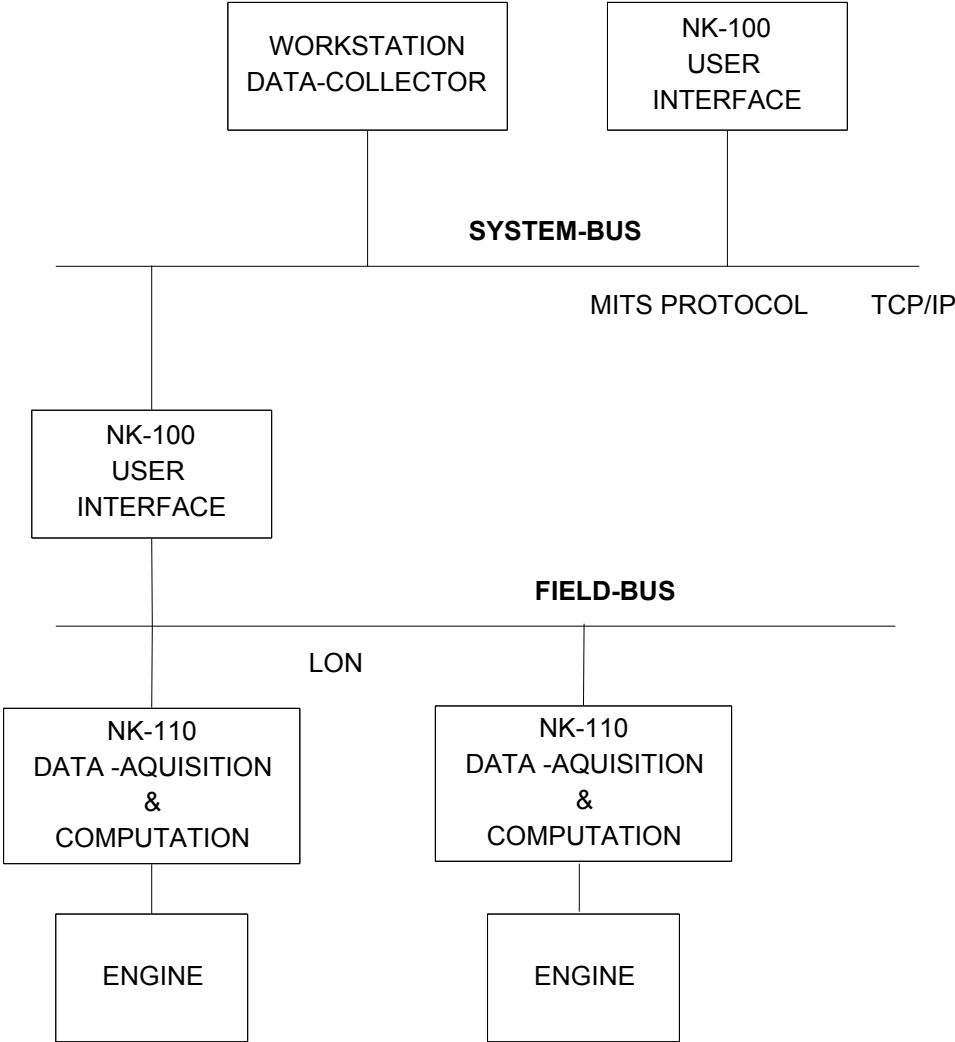A machine used to measure the work delivered by a diesel-engine. Autronica pioneered electronic MIP-calculation with NK-3 (1976). Later NK-4 (1978) and NK-5 (1985) have had a substantial impact on the market.

MIP = Mean Indicated Pressure
 The **calculated** constant pressure (in **bar**) which, if supplied to a cylinder, will supply the *actual* power that the cylinder delivers during one cycle.

System Block Diagram

```
┌─────────────────────┐        ┌─────────────────────┐
│    WORKSTATION      │        │      NK-100         │
│  DATA-COLLECTOR     │        │      USER           │
│                     │        │    INTERFACE        │
└──────────┬──────────┘        └──────────┬──────────┘
           │                              │
     ─────┬─┴──────── SYSTEM-BUS ─────────┴────────────
          │
          │              MITS PROTOCOL      TCP/IP
          │
┌─────────┴───────┐
│     NK-100      │
│     USER        │
│   INTERFACE     │
└─────────┬───────┘
          │                    FIELD-BUS
     ─────┴──────────────────────────┬───────────────
          │         LON              │
┌─────────┴───────┐        ┌─────────┴───────┐
│    NK-110       │        │    NK-110       │
│ DATA -AQUISITION│        │ DATA -AQUISITION│
│       &         │        │       &         │
│  COMPUTATION    │        │  COMPUTATION    │
└─────────┬───────┘        └─────────┬───────┘
          │                          │
┌─────────┴───────┐        ┌─────────┴───────┐
│     ENGINE      │        │     ENGINE      │
└─────────────────┘        └─────────────────┘
```

System Components

MS-Windows 3.1 & MS DOS
PC-AT Compatible
Borland Pascal & ObjectWindows
LON
TRANSPUTERS
Occam
MITS / TCP/IP

```
        ┌──────────────┐        ┌──────────────────┐
        │              │        │     NK-100       │
        │ WORKSTATION  │        │      PC          │
        │    UNIX      │        │  MS WINDOWS      │
        │    MITS      │        │ BORLAND PASCAL   │
        │              │        │     MITS         │
        └──────┬───────┘        └────────┬─────────┘
               │         SYSTEM-BUS      │
        ───────┴─────────────────────────┴──────────────
              MITS PROTOCOL         TCP/IP
   ┌──────────────────┐
   │     NK-100       │
   │      PC          │
   │  MS WINDOWS      │
   │ BORLAND PASCAL   │
   │     MITS         │
   └────────┬─────────┘
            │       FIELD-BUS
     ───────┴──────────────────────┬─────────
         LON
   ┌──────────────┐        ┌──────────────┐
   │   NK110      │        │   NK-110     │
   │   OCCAM      │        │   OCCAM      │
   │ TRANSPUTERS  │        │ TRANSPUTERS  │
   └──────┬───────┘        └──────┬───────┘
   ┌──────┴───────┐        ┌──────┴───────┐
   │   ENGINE     │        │   ENGINE     │
   └──────────────┘        └──────────────┘
```
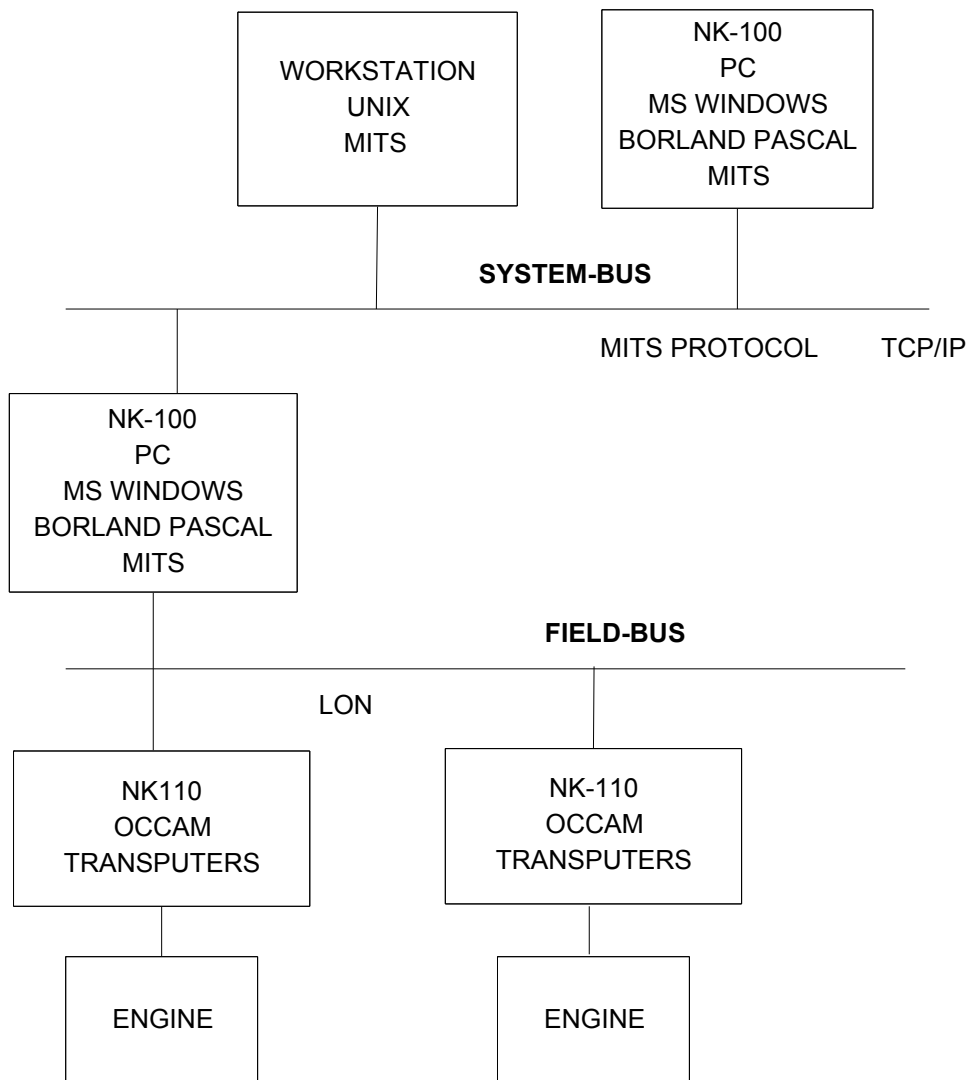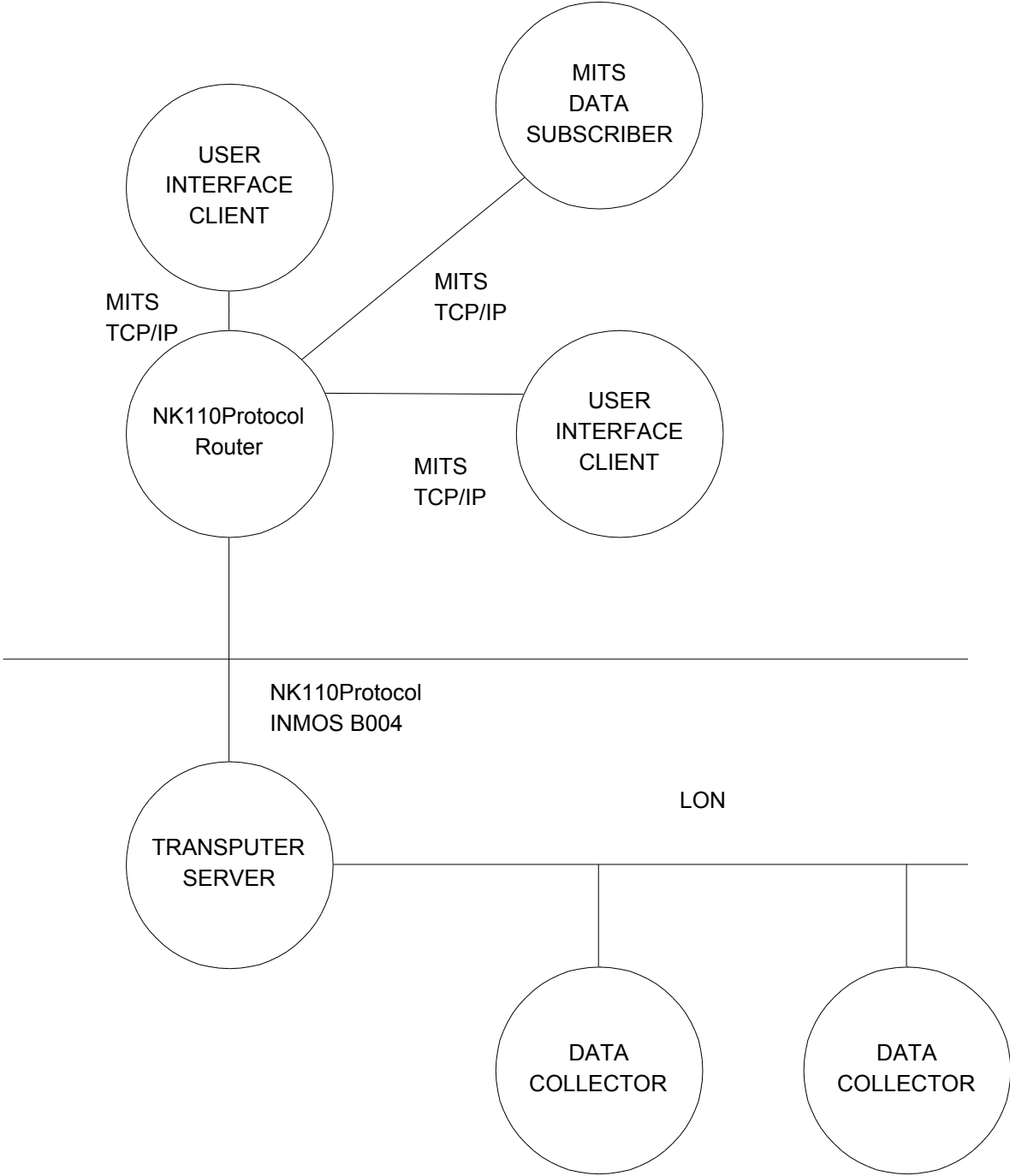
USER INTERFACE
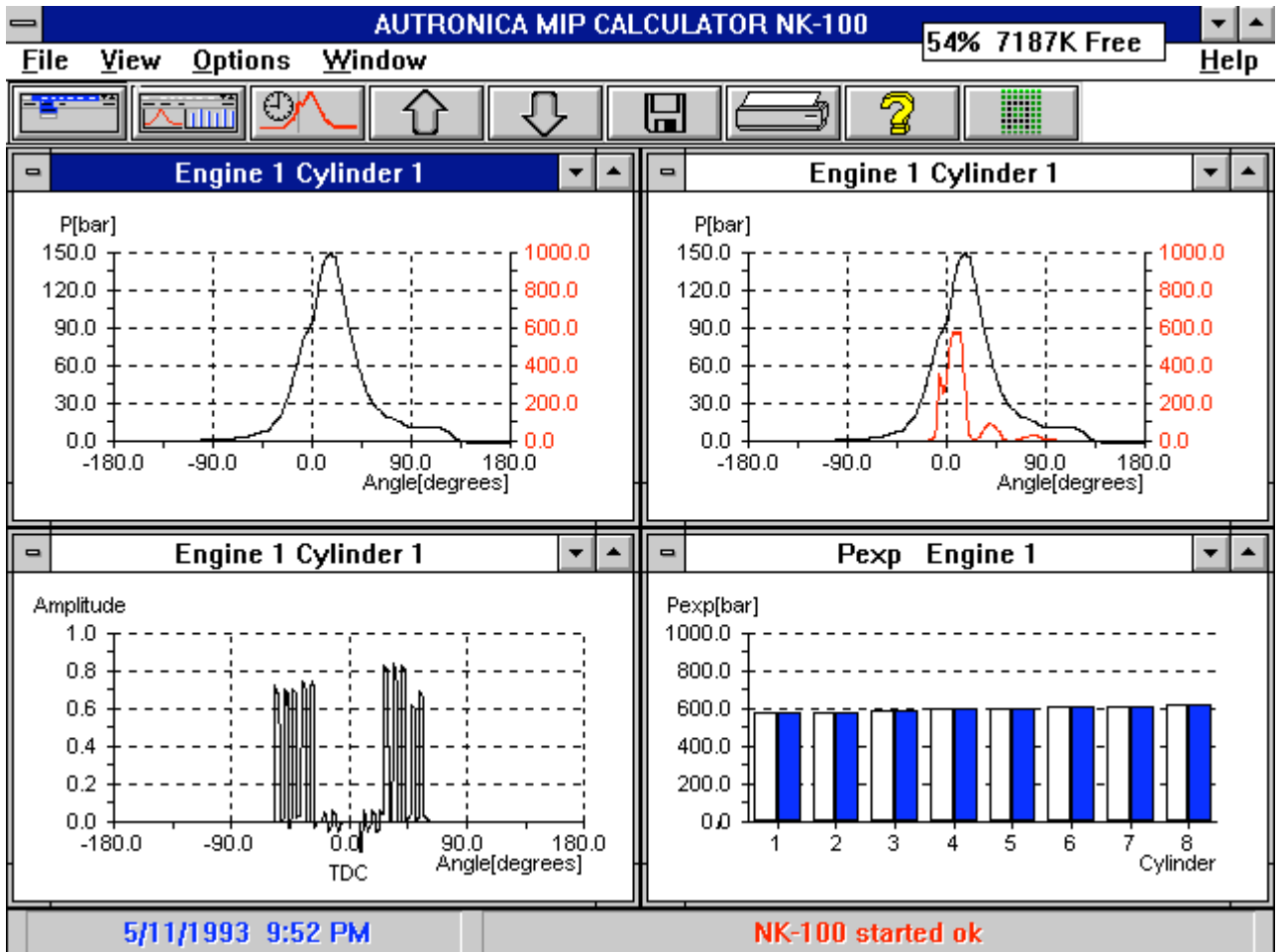
Communication Protocols
MITS & TCP/IP
INMOS B004 Protocol
NK110Protocol

MITS
DATA
SUBSCRIBER

USER
INTERFACE
CLIENT

MITS
TCP/IP

MITS
TCP/IP

NK110Protocol
Router

USER
INTERFACE
CLIENT

MITS
TCP/IP

NK110Protocol
INMOS B004

LON

TRANSPUTER
SERVER

DATA
COLLECTOR

DATA
COLLECTOR

NK110Protocol
- a PC-transputer protocol, specification

- Multiple Windows programs shall access the engines simultanously

  Solution

- Each Windows application is a client.

- A server is running in the transputer network

- The server administrates the clients or the subscribers.

PC-transputer protocol, principles

1. Master-slave communication with directive-answer pairs. This is called "blocking" communication.

2. One-way only - down to the transputer. Answer is sent only if an error occurs.

3. One way only - up from the transputer. This is called "spontaneous".

PC-transputer protocol, naming

Type 1, 2 or 3 is reflected in the naming of the protocol elements:

Name :
`"<function>.<next>"`

From host to transputer:

A	`"name.Ack"`	Blocking (master-slave). Answer is `ack` only.
B	`"name.AckPlus"`	Blocking (master-slave). Answer is `ack` followed by one answer in group E.
C	`"name.NackOnError"`	Not blocking. Answer is `nackOnError` if error found.

From transputer to host:

D	`"name.Spontaneous"`	Not-asked-for messages. No answer.
E	`"name"`	Answers to directive in group B, after `ack`.

Acknowledge to host:

`"ack"`	Acknowledge to groups A or B directives.
`"nackOnError"`	Acknowledge to group C directives.

PC-transputer protocol, example

```
PROTOCOL ToFromHost
  CASE
    ack;
      BYTE; -- tagOfCommand
      BYTE; -- indexOfNode
      BYTE  -- classReason
    nackOnError;
      BYTE; -- iSubscriber
      BYTE; -- tagOfCommand
      BYTE; -- indexOfNode
      BYTE  -- classReason
    removeSubscriber.Ack;
      BYTE -- iSubscriberOld
    addSubscriber.AckPlus
    addSubscriber;
      BYTE -- iSubscriberNew
    registerCurve.NackOnError;
      BYTE; -- iSubscriber
      BYTE; -- indexOfEngine
      BYTE  -- indexOfADChannel
    message.Spontaneous;
      INT16::[]BYTE -- size::[SizeOfText] text
    causeerror.Spontaneous;
      BYTE;             -- indexOfNode
      REAL32;           -- secondsToCauseerror
      INT16::[]BYTE;    -- size::[SizeOfText] text
      BYTE              -- classReason
:
```
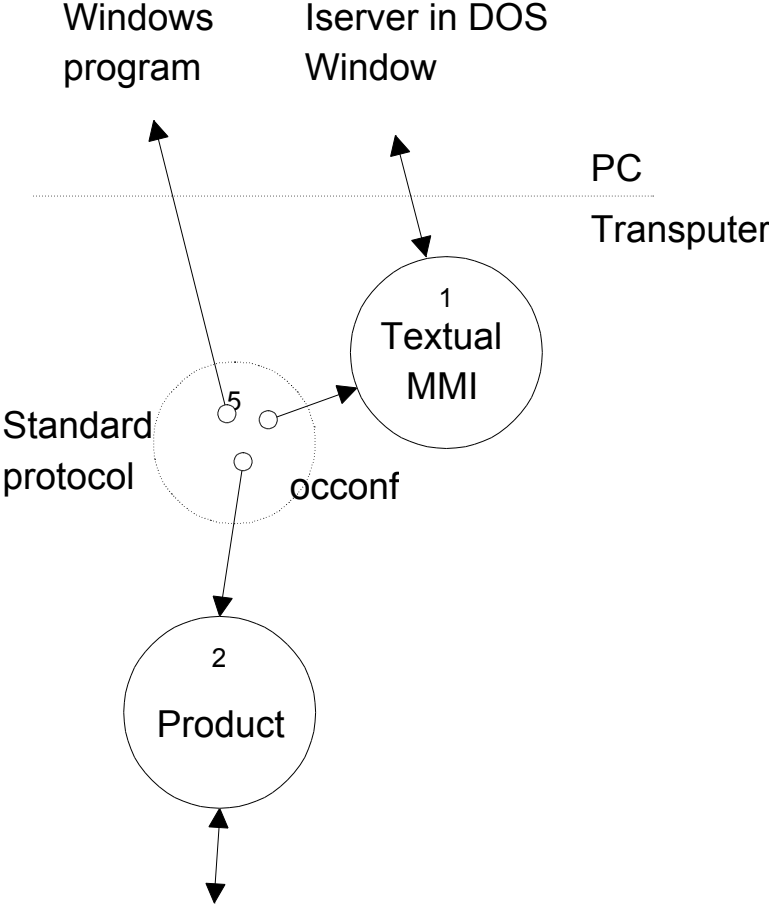
Windows and Iserver coexisting during the development phase

Windows
program

Iserver in DOS
Window

PC

Transputer

1
Textual
MMI

5

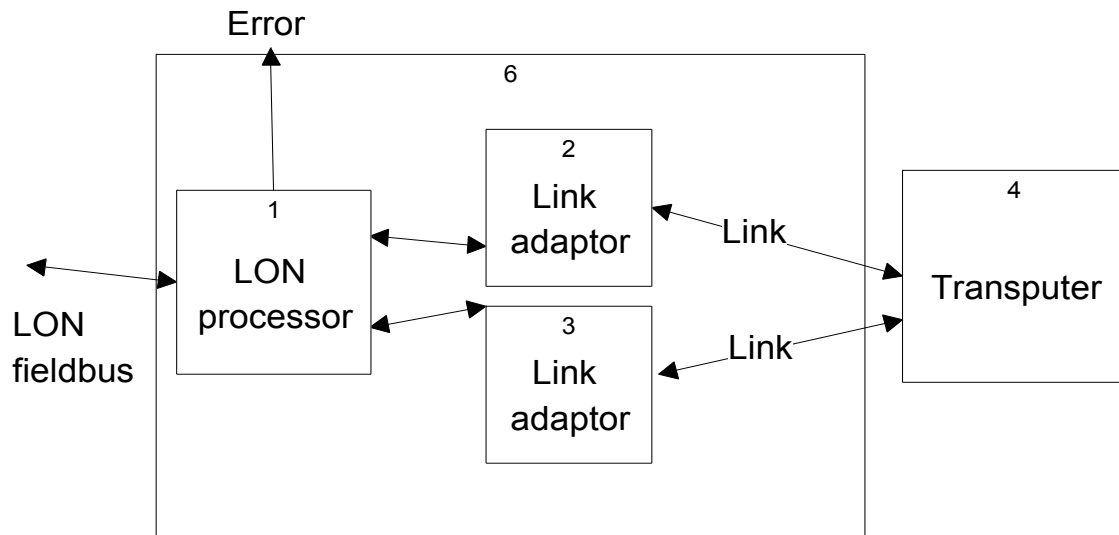Standard
protocol

occonf

2
Product

PC Transputer Network Communication
LON™ - concept

- Designed by Echelon, USA.
- LON = Local Operating Network
- Multi-master
- CSMA/CD = Carrier Sense Multiple Access / Collision Detection
- Neuron processor (=LON processor) contains both network processors and processor to execute user defined code (Neuron-C).
- Neuron-processors produced by Motorola and Toshiba.
- Communication rate up to 1.25 Mbit/Sec. @200m. (2000m at 78kbit/Sec.)

LON - TRAM

Error

```
                                    6
              1              2                        4
                          Link
  LON                    adaptor         Link
  processor                                        Transputer
  LON                       3
  fieldbus               Link            Link
                         adaptor
```

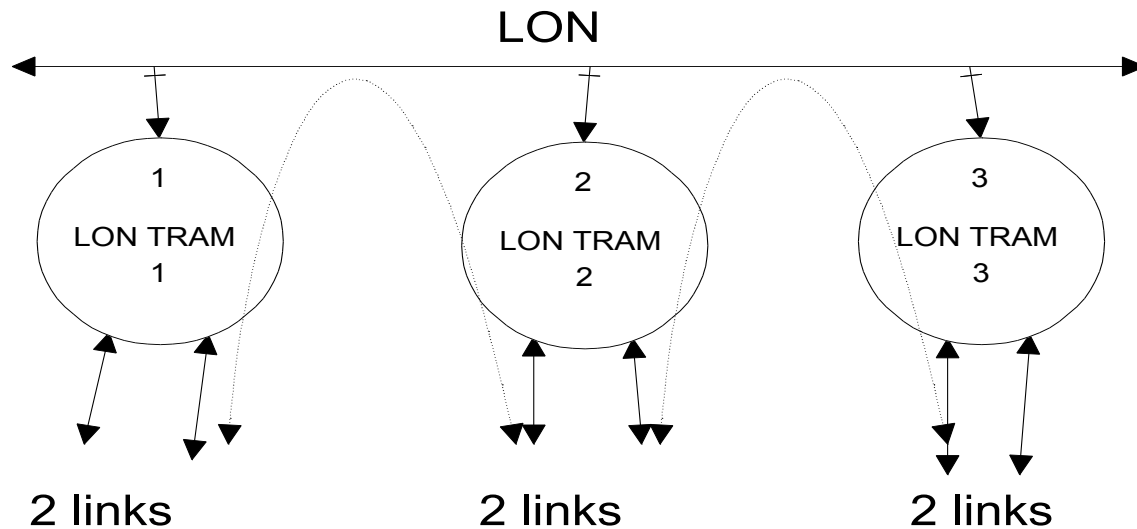Neuron processor at 5Mhz, LON speed 78 kbit/Sec.
Link to link speed:
· 10 kbit/Sec. one direction,
· 12 kbit/Sec. simultaneous bidirectional (6 kbit/Sec.
  each direction).
Utilizes 30% of LON capacity.
TRAM is SIZE 2

· Analyse, reset and error implemented.
· Subsystem port implemented.

The LON-TRAM is compatible with all INMOS
development tools.

LON - TRAM node address set by switch.

LON -TRAM occam pipeline

- LON - TRAM node address set by switch.
- Root / not root by jumper.
- Up / down links not configurable.
- LON is transparent (not seen by occam)