Neural Network Applications in Telecommunications

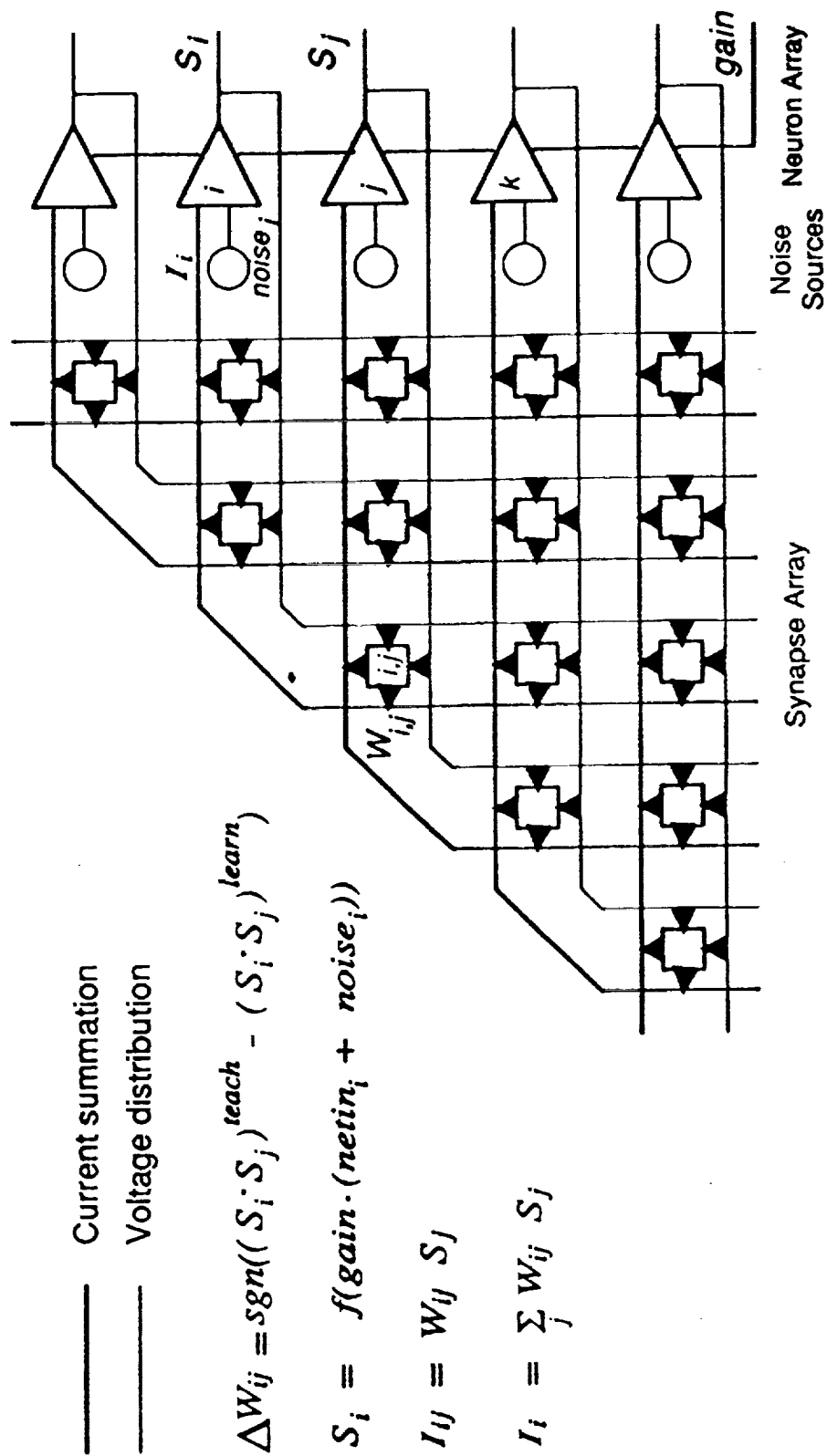## Joshua Alspector

Bellcore; Morristown, NJ

Neural Network Capabilities

● **Automatic and Organized Handling of Complex Information**

- Where rules are not known or there are too many for an expert system, neural networks can encode knowledge by learning using training data. This is easy and can give good results quickly.

● **Adapts to Continuously Changing Environment**

- The adaptive equalizer, a simple neural network, can maintain a high level of performance and is used in millions of modems.

● **Non-linear Modeling**

- For control, equalization, or modeling of complex systems, neural networks are inherently non-linear in their fit to data. They can give results superior to traditional linear methods.

● **Parallel Implementation**

- For problems where the data rate is too high for serial processing, parallel hardware based neural nets can provide dramatic speedups.

Bellcore Work on Applications

- **Proprietary Neural Network Hardware**

  – Adaptive equalization

  – ATM admission control

  – Optimization (Packet routing, Channel assignment, Multi-user detection)

- **New Services**

  – Adaptive user interface for information filtering

  – Financial and market prediction

  – Auditory localization for multipoint teleconferencing

- **Operations**

  – Fraud detection

  – Traffic characterization for differential billing

  – Fault identification

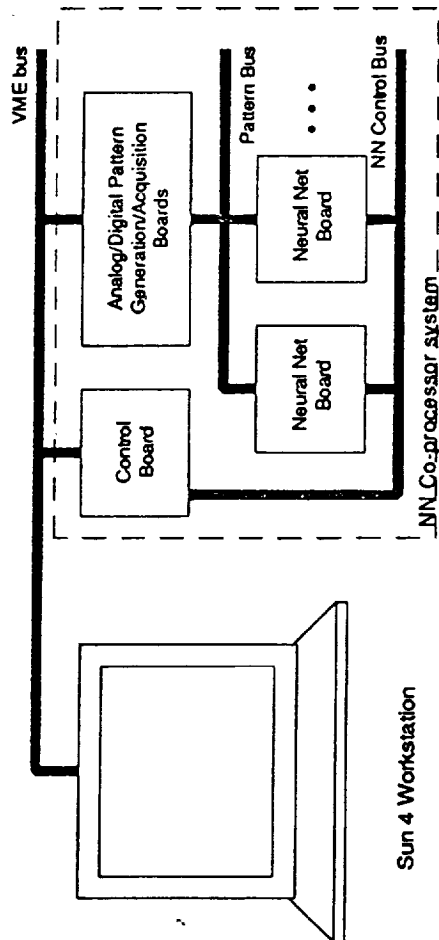 – Software reliability prediction
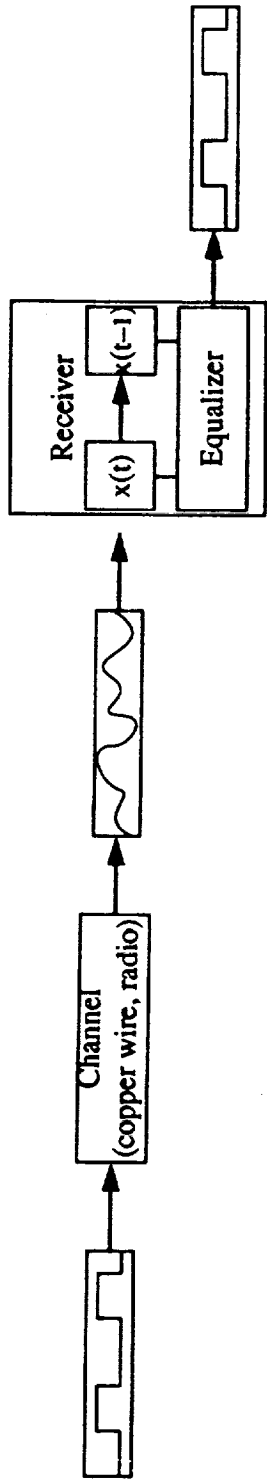
211

Learning Chip Computational Function

—— Current summation
—— Voltage distribution

$\Delta W_{ij} = sgn((S_i \cdot S_j)^{teach} - (S_i \cdot S_j)^{learn})$

$S_i = f(gain \cdot (netin_i + noise_i))$

$I_{ij} = W_{ij} S_j$

$I_i = \sum_j W_{ij} S_j$

S_i

S_j

I_i

$noise_i$

W_{ij}

gain

Neuron Array

Noise Sources

Synapse Array

Learning System - Block Diagram

Analog/Digital Pattern Generation/Acquisition Boards

Control Board

Neural Net Board

Neural Net Board

VME bus

Pattern Bus

NN Control Bus

NN Co-processor system

Sun 4 Workstation

Neural Network Equalization

Equalization

Neural Hardware
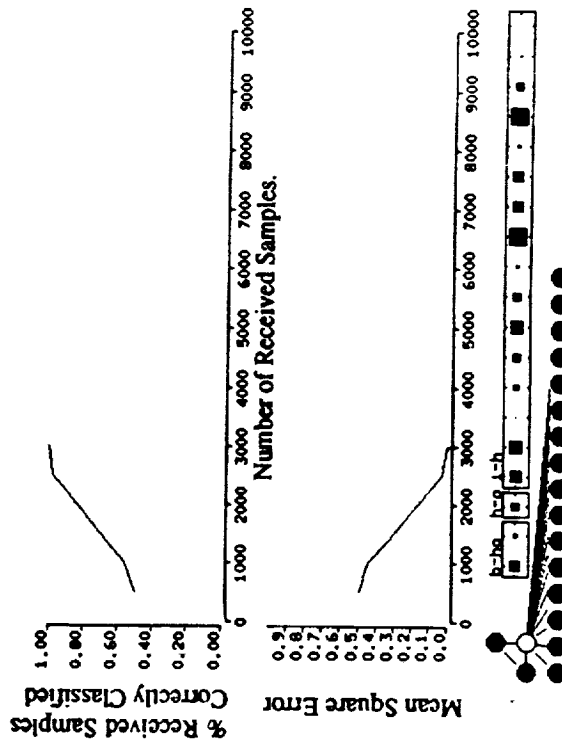
Processing Speed (samples/second)	
Current Test Platform	10,000
Limit of Current Chip	100,000
Chip Dedicated to EQ	1,000,000

Analog neural network uses 20 times less power than similar speed digital.
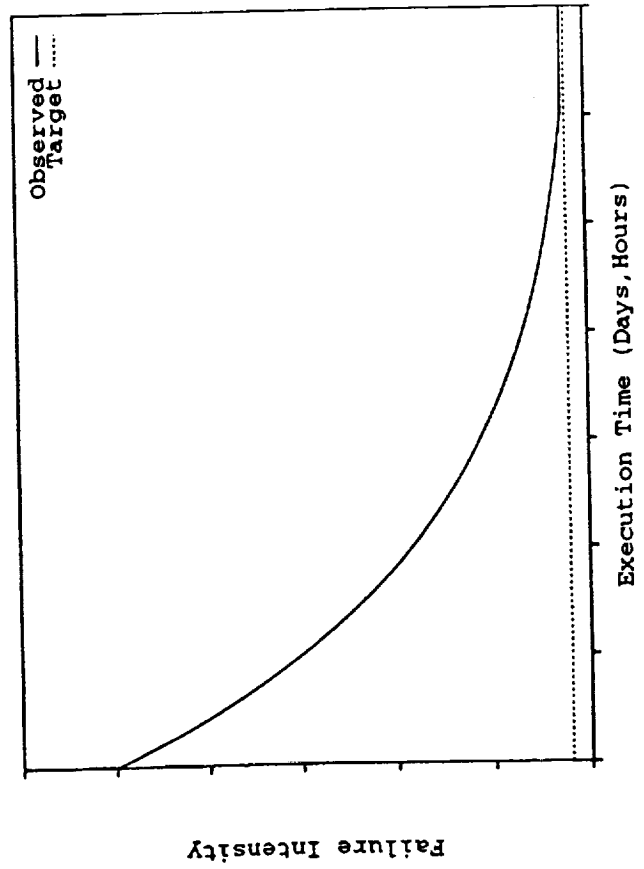
Broadband Access Control
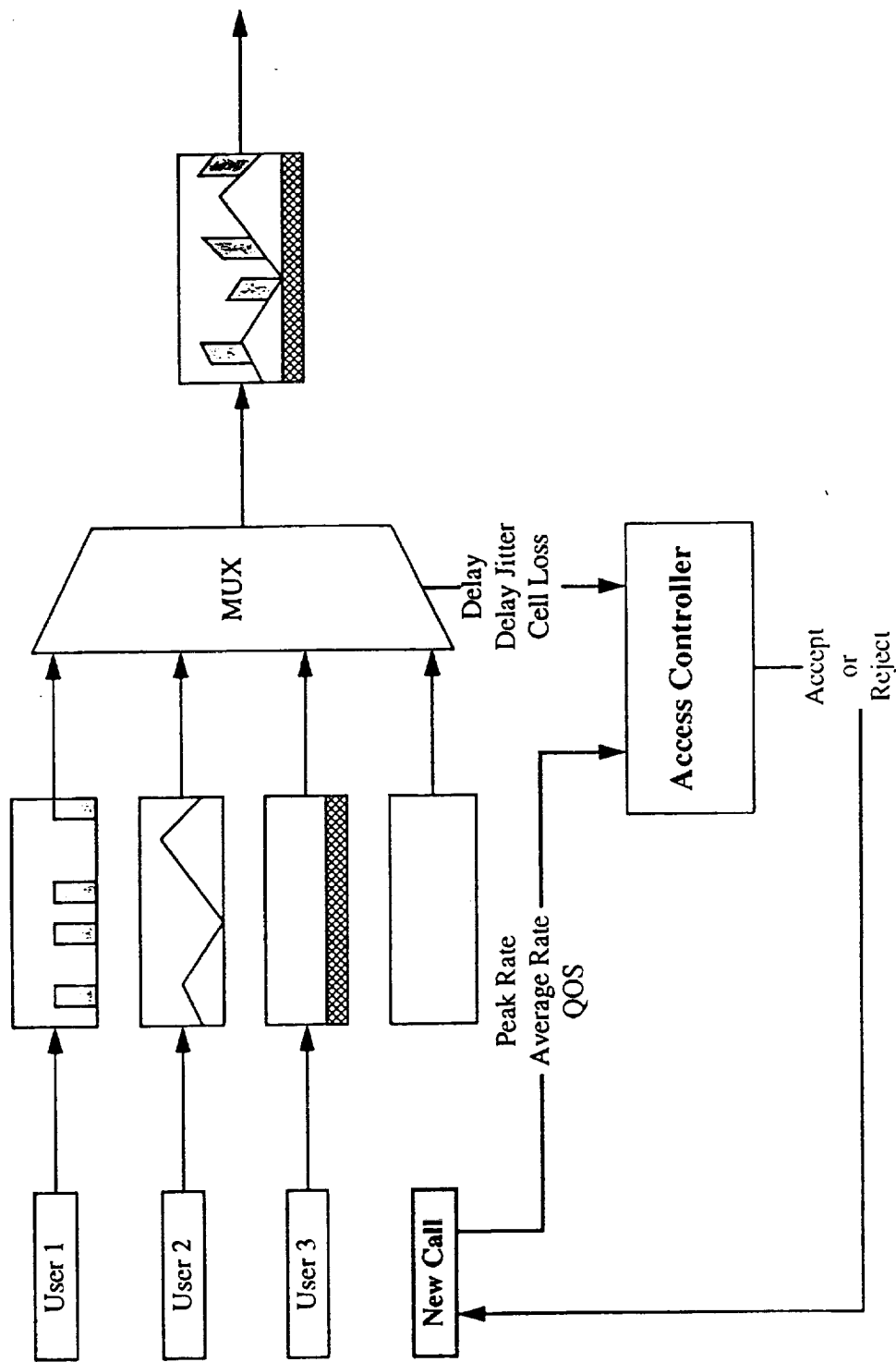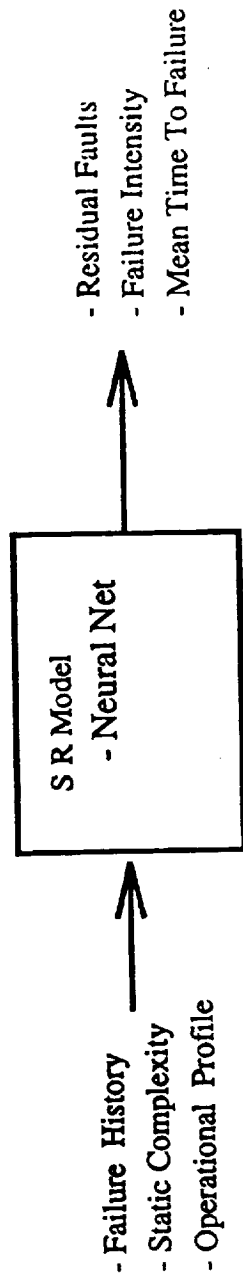
Calling-Card Fraud Detection

Suspicious Activity Alarm

CRIS

BOSS

Adaptive Pattern Analysis

Calling Card Number
Terminating Number
Originating Number
Frequency of calls
Number of calls
Type of User
. . .

LIDB

SS7 Queries

216
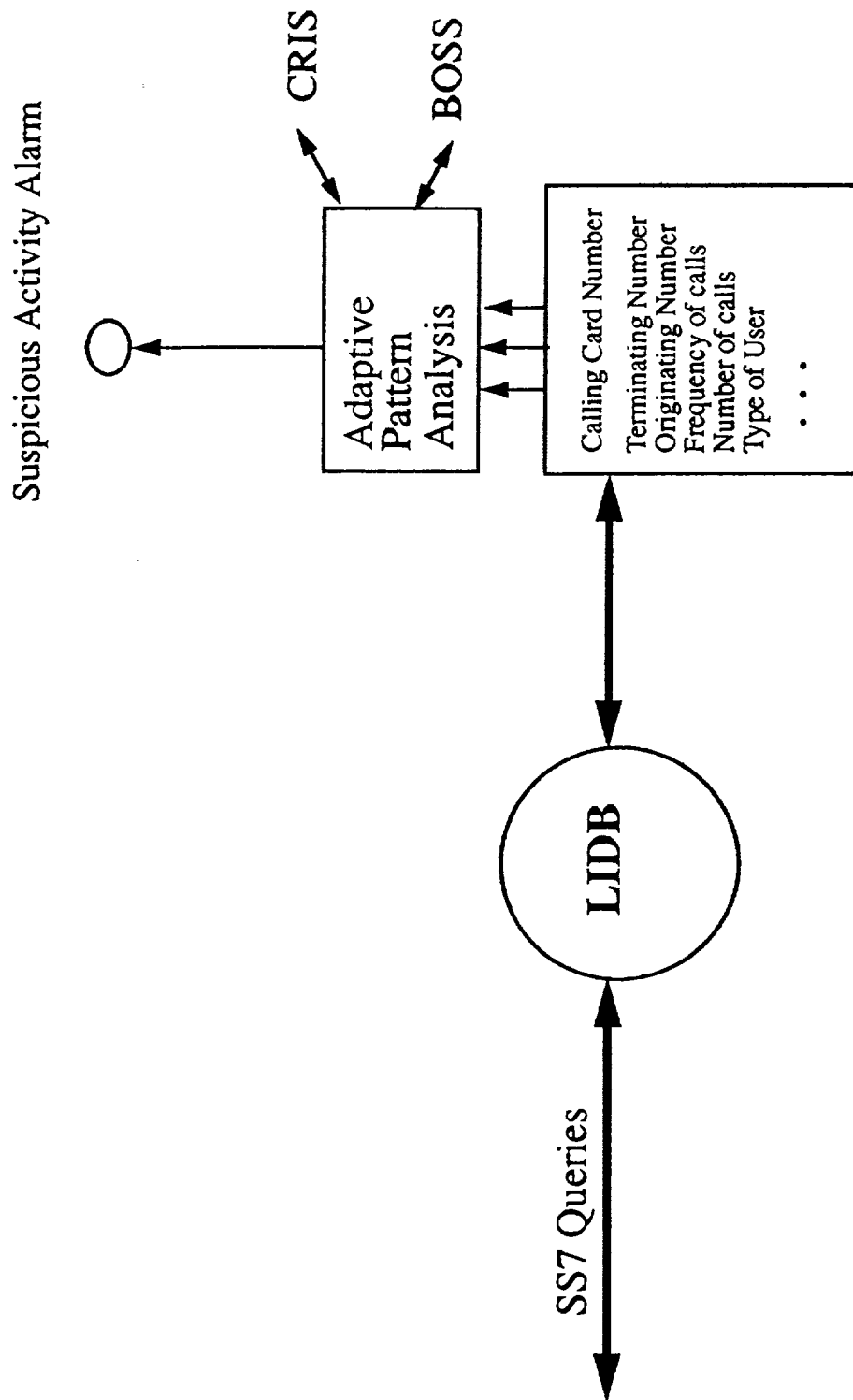
Software Reliability Prediction (Cont.)

An Overview :

- Failure History
- Static Complexity
- Operational Profile

→

S R Model
- Neural Net

→

- Residual Faults
- Failure Intensity
- Mean Time To Failure

Observed ——
Target ·····

Failure Intensity

Execution Time (Days, Hours)

Conclusions

- **Quality**
  - Adaptive equalization
  - Fault identification
  - Software reliability

- **Efficiency**
  - Coding, compression
  - Routing, scheduling

- **Operations**
  - Network management

- **Interfaces**
  - Speech and pattern recognition
  - Adaptive information filters

- **Communication systems and their customers benefit from adaptive and intelligent systems**

218