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3D ARTIFICIAL NEURAL NETWORK (3DANN) TECHNOLOGY

A Status Report And Blueprint For The Future

Irvine Sensors Corporation Presentation to the Workshop:

"A DECADE OF NEURAL NETWORKS: PRACTICAL APPLICATIONS AND PROSPECTS"

by

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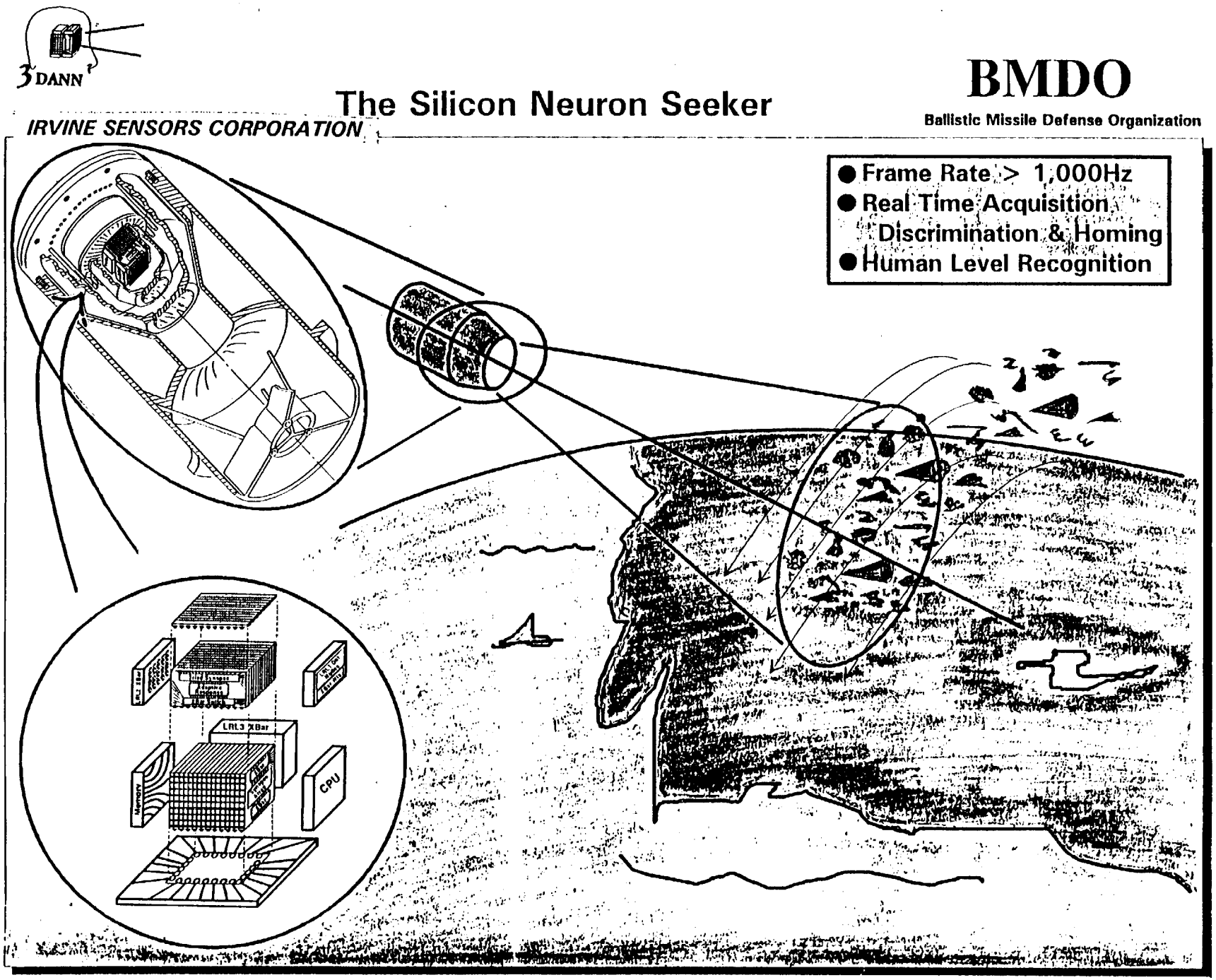
3D Artificial Neural Network (3DANN) Technology
A Status Report and Blueprint For The Future

Irvine Sensors Corporation (ISC), working closely with JPL under BMDO/ONR sponsorship, is developing a radically new neural computing technology. Primarily aimed at discrimination and target recognition for BMDO missile interceptor applications, it appears to have near term commercial applicability to such problems as handwriting and face recognition, just to name two. In its earliest form it will be able to perform inner product computation using 262 thousand 64x64 templates (weighted synapse arrays) where the 64^5 weights can all be changed every milli-second. Internal switching provides an inherent capability to zoom,. translate, or rotate the templates. The 3D silicon architecture is manufactured on a commercial, high volume DRAM production line at very low cost, enabling its commercialization. Two technology thrusts are beginning: In the first, the 64 layer capability of 3DANN-I will be extended to 1024 layers and beyond. In the second layer size will be shrunk to 2-3 millimeters to reduce layer costs to under fifty cents.

Our workshop goal is to expose this technology to the neural network community as an emerging tool for their use and to obtain their desirement for its future development.


3 DANN
The Silicon Neuron Seeker
BMDO
Ballistic Missile Defense Organization
IRVINE SENSORS CORPORATION
● Frame Rate > 1,000Hz
● Real Time Acquisition, Discrimination & Homing
● Human Level Recognition
LRL3 XBar
CPU

The 3DANN FPA Implements Many Neural Network Architectures & Algorithms Real Time

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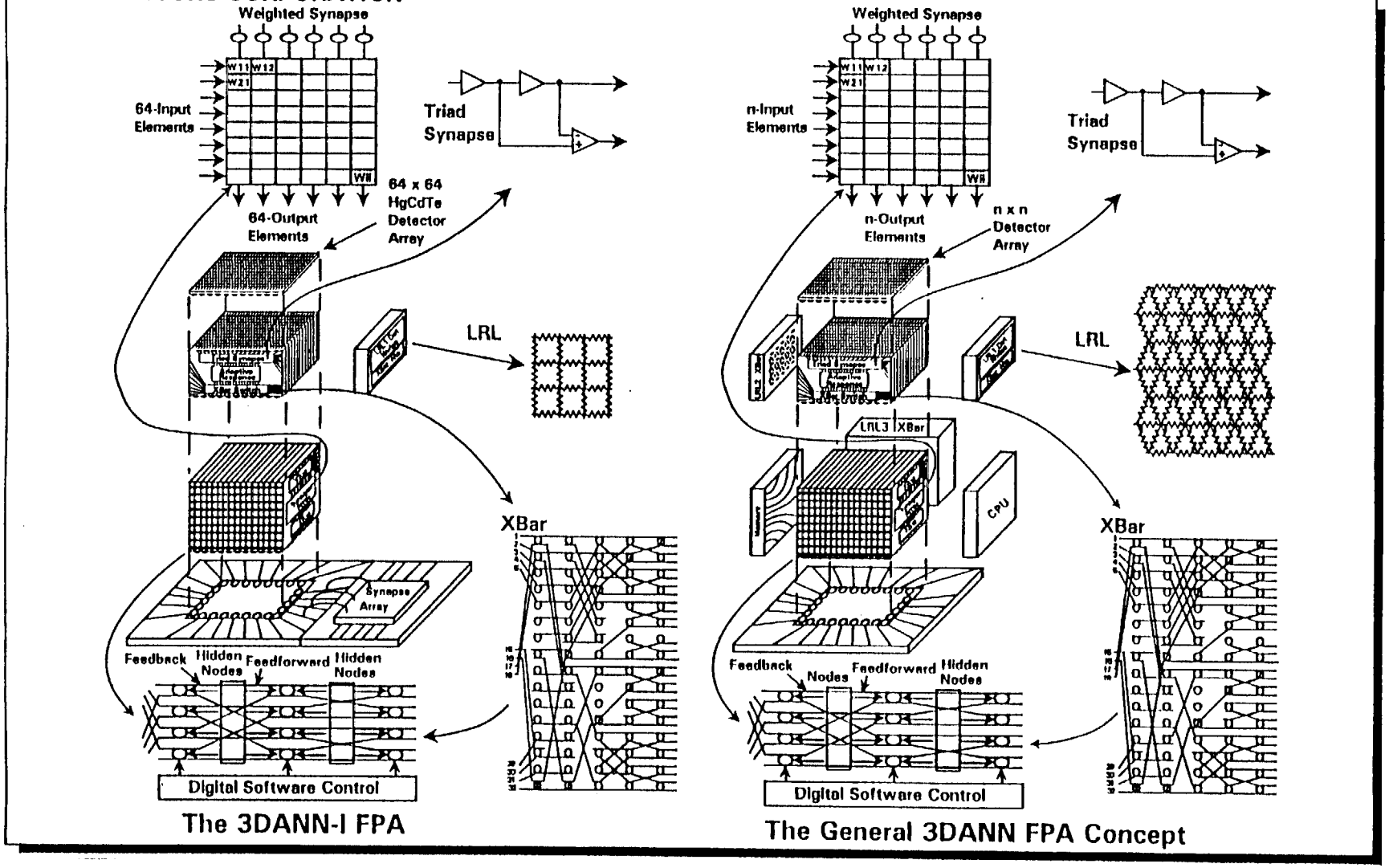

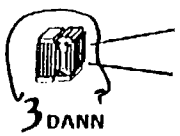

SILICON NEURON SEEKER TECHNICAL OVERVIEW

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- SIGNIFICANT ARCHITECTURAL ISSUES IDENTIFIED AND ADDRESSED
  - Windowing and optimum allocation of weight space impacted the NCM design
  - A promising new approach based on a JPL innovation to be considered for 3DANN-II
- NCM DESIGN NOW COMPLETE AND AT FINAL LAY-OUT
  - Fast cross-bar to facilitate windowing
  - Post-layout simulation results appear excellent
- NPM IC CRITICAL CELLS THROUGH TEST AT JPL
- 3DANN-I HARDWARE EMULATOR NEARING COMPLETION
  - NCM and NPM modules at test
  - Major process hurdles overcome for multi-face processing and bump-bonding
- HARDWARE SIMULATION TOOLS IN PLACE AND DEMONSTRATED

3DANN Architecture

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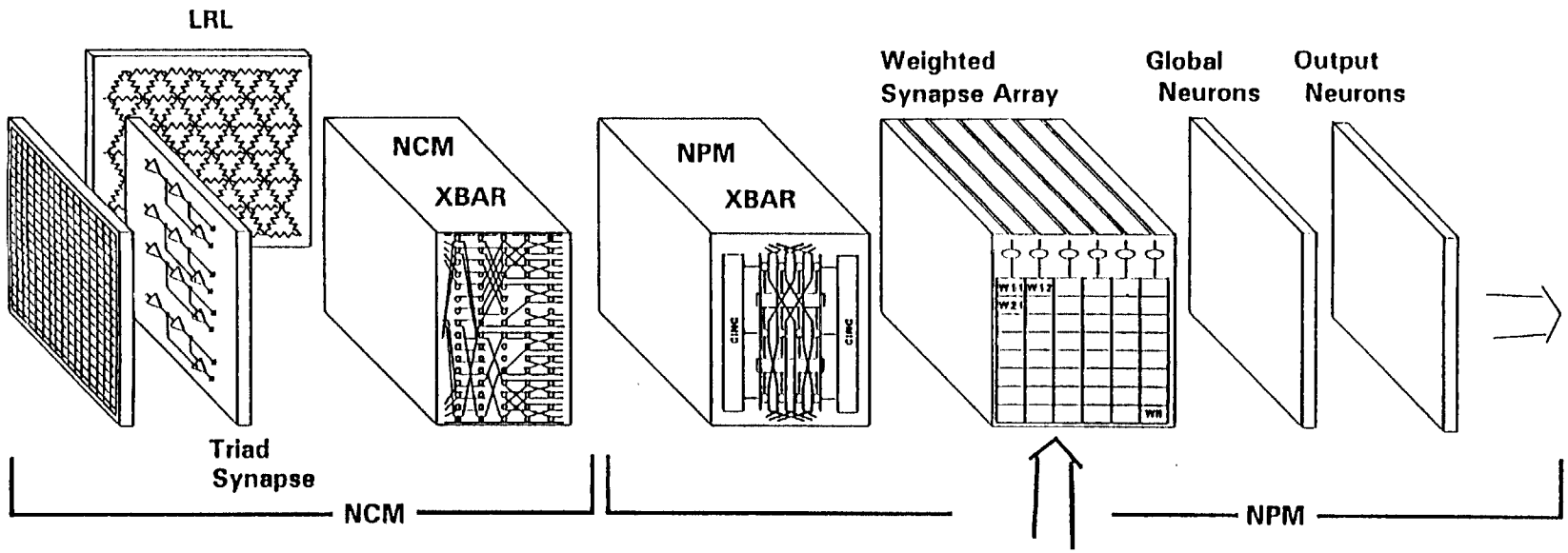

- n^2 unique paths/weights per pixel
- n^4 x n weight space
- n^3 n x n templates
- n^5 weight changes per frame
- One frame = 10^{-3} seconds

	n = 64	n = 1024
Weights	10^9	10^{15}
Templates (nxn)	262K	10^9

Window Grabber Architecture

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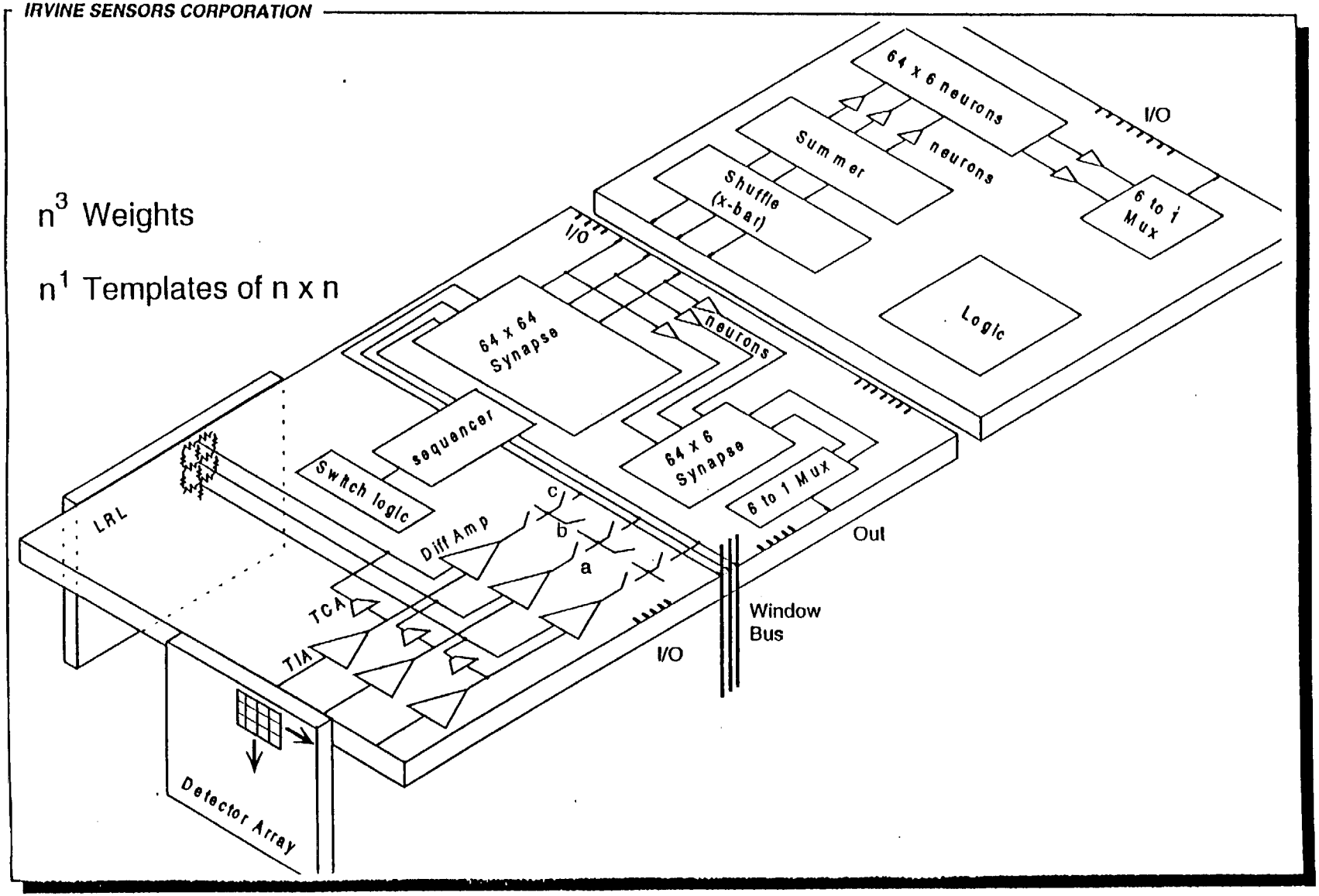
n^3 Weights

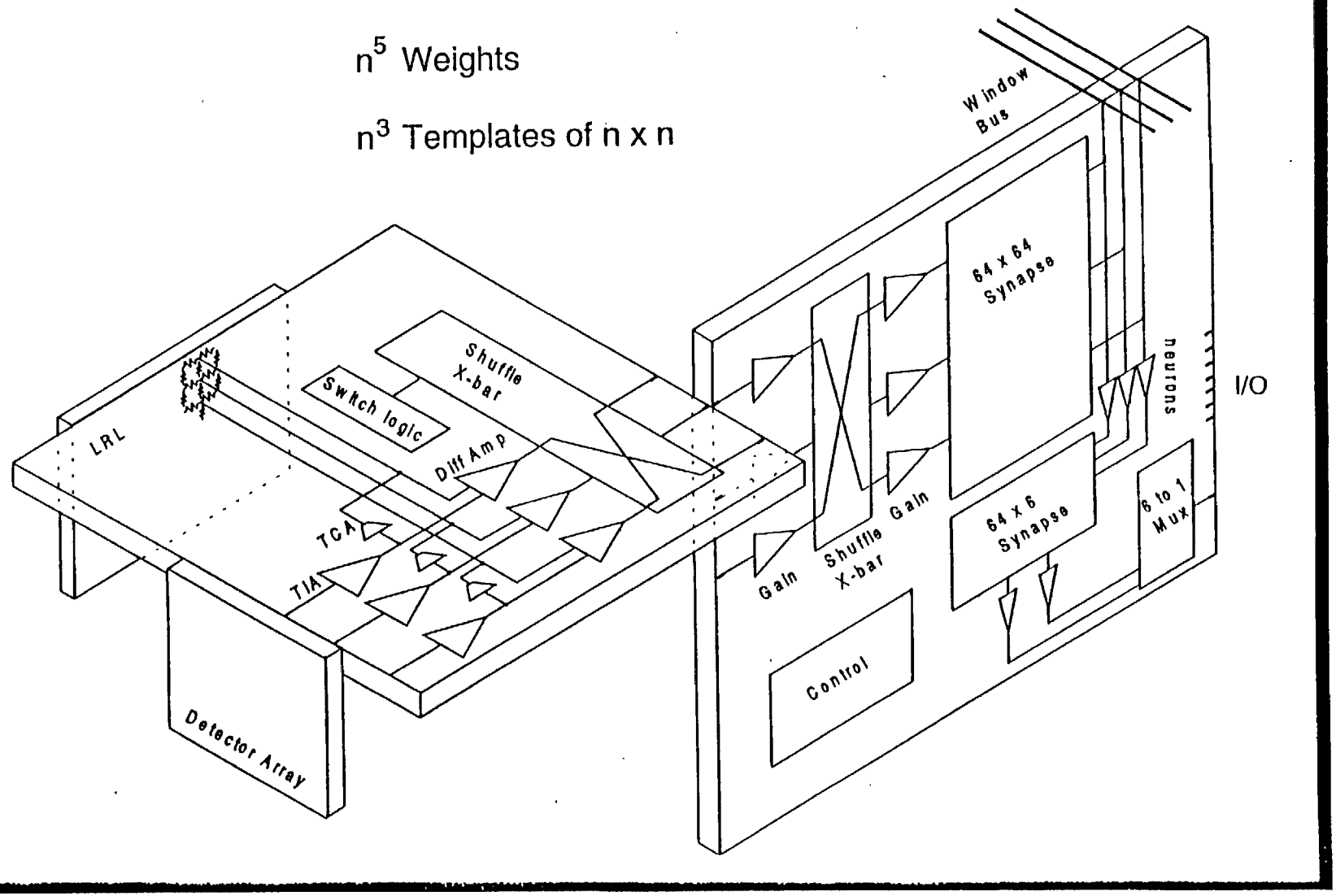
n^1 Templates of n x n



Baseline Perfect Shuffle Architecture

n^5 Weights

n^3 Templates of n x n



Legacy to Military Applications

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Neural Network Technology

Cap Chip Technology

Memory Products

3DANN-I

BMDO

Interface to standard imagers

Flexman

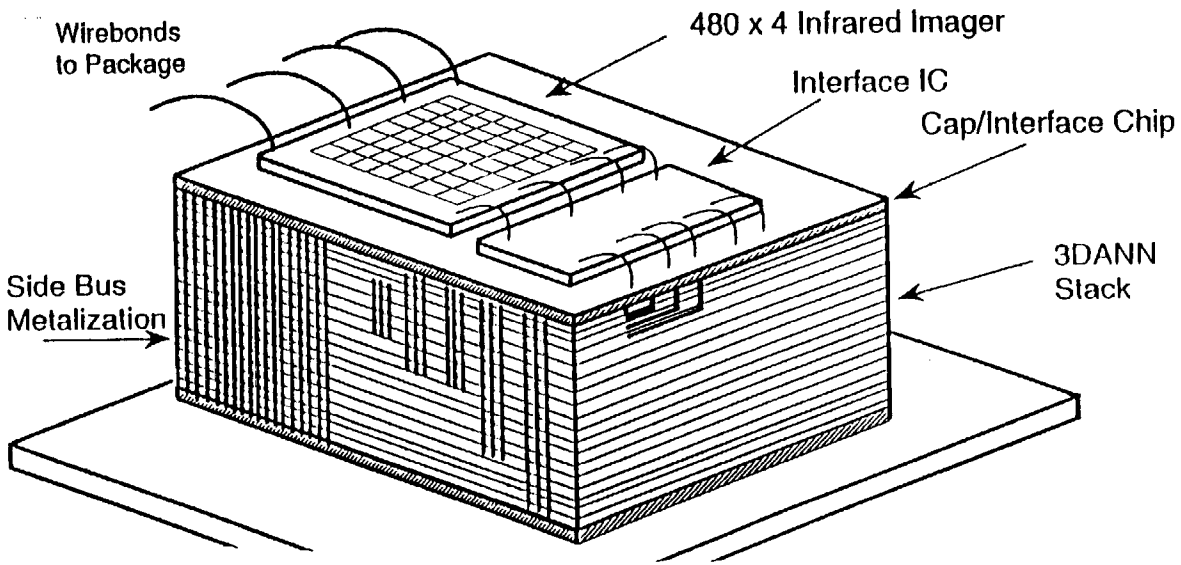
3D SRE

ARPA/Grumman

NASA JPL

MUSTRS

ARPA/Martin Marietta



THE PDA CHARACTER RECOGNITION APPLICATION

3DANN

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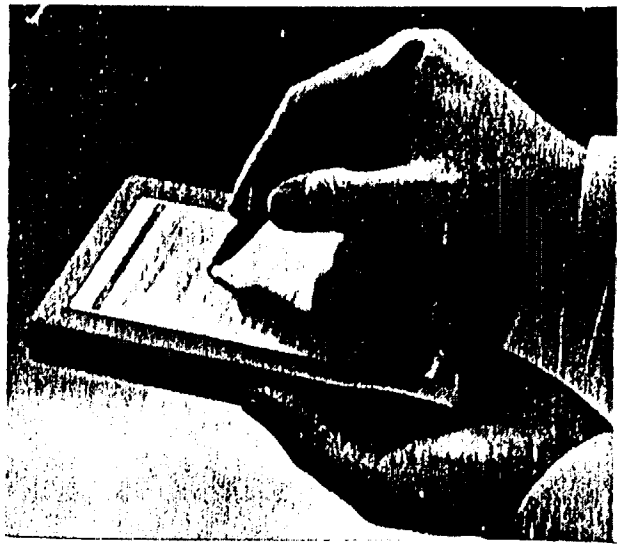
IRVINE SENSORS CORPORATION

- 3DANN IS AN OVERKILL
- THE ISSUE IS COST
- THE SOLUTION:
  - Miniaturize the IC's to 100x25 mil^2
  - $0.50 per IC
- THE COST ≃ $2M TO PRODUCTION
- 100X100X50 MIL^3 PACKAGE FITS IN STANDARD SOJ PACKAGE



- AS ANYONE WHO OWNS A PDA KNOWS, THIS UNIT WILL OPEN UP A VCR SIZE MARKET
- ONE BILLION DOLLAR SALES IN FIVE YEARS