Discussion of Rational Hardware

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by Mike Druke

Director of Hardware

Rational Employee #17

I will be talking about something we designed 40 years ago, so forgive this old man's memory!

Well maybe not too old.
These are from the last few
days in Copenhagen

To establish my Nerd credentials, yesterday at Hamlet's Castle I made a Riddle:

What does

0xD4 have to do

with Hamlet?

D4 = not 2B

Personal Notes:

Dad at 92 Deer Hunting

- Born in Vermont

3 years old, picking potatoes with my Sisters

- Found Passion for Hardware at MIT

- Roomate with Dave Bernstein
  Rational VP of Engineering

- Designed BFD6900 in 1971
  with Dave at Digital Systems Lab
  I am as happy doing Hardware now
  as I was in this Picture 51 years ago!

- Designed Nova 2 with Dave
  at Data General in 1972

- Joined Rational as employee #17
  as Director of Hardware in Jan 1982.
  Dave was VP Engineering.
  Left in 1995.

Mike Druke, 18, Spring 1971 at MIT Digital Systems Laboratory with the "BFD 6900"

Early Rational Culture

- Founded in 1981 by 3 Air Force Academy graduates who saw the potential of ADA:
  Paul Levy   – President
  Mike Devlin   – CTO
  Grady Booch – Software Architect

- Paul and Mike worked at "The Blue Cube" AF base.
  They came to work often in their Captain's uniforms.

- First financing from Arthur Rock, COB, financier of Intel and Apple.
  On a demo of the 1st Prototype, he asked me "Where is the Compiler",
  I pointed to the disk

- Rule #1, no one leaves on Thursday.
  Company BBQ followed by Seminars communicating progress in all areas.
  Usually lasted past Midnight.
  We all knew what each other was working on.

- We went to Grand China together on Friday night. Lots of work done.

- We had company picnics in the summer.
  The first one was at the home of William Perry, former DOD Secretary,
  board member, father of the cruise missle.

Early Design Decisions

- We would use CAD. This was in it's infancy in 1982.
Mike Devlin and I visited Daisy during my job interview and bought 2 on the spot.

- We would go straight to PCB, avoiding time and frustration of Wirewrap or other prototype methodology.
    This required a Simulator, no problem, Sofware R us! Written in ADA.

- We would design powerful Diagnostic capability.
The 8051 based Diagnostic "Archipelago"
This was invaluable for Hardware debugging, Manufacturing, and Service.

- We would have a Backplane and a Foreplane.
This made layout much easier for multiple 64-bit busses.

- We would go with our Strengths and avoid IO design,
This resulted in the World's most expensive Unibus peripheral!
The first quad processor Series 100 had 4 PDP11 minicomputers.

Diagnostics

- Every board could drive and receive all its external pins.
  All registers scannable or could load into scannable register.

- We built a Lab Test jig with a ZIF Backplane connector and tested all boards stand alone. This was adapted by manufacturing.

- Chris Jacques wrote the 8051 Experiment interpreter using only 23 bytes of RAM. This allowed for 105 byte Experiment objects.

- Each HW designer wrote over 50K lines of Pascal Diagnostics.

- Hardware would "Freeze" on error and a "Tombstone" file was created for Post Mortem Diagnostics to analyze to identify FRU.

- Our first HW failure was at Lockheed. Our field guy showed up with replacement board BEFORE they knew it crashed!

Board Partitioning and Hardware Team

- Mike Druke (MBD) did MEM board. Blazed the trail for layout and Daisy.
  1st design was 8 Mbytes with 256K X 1 Dynamic Rams.
  16 Set Associative design from Logical Address.
  This avoided the need for a traditional Address Translation Unit.
  The Architecture has no Physical Address.

  128 bit bus with ECC.

  The PCB fab house rejected initial design because there were way fewer Vias than their formula of Component Pads to Vias predicted.
  Example of "Gestalt Design" methodology.

VAL, TYP and FIU boards

- Steve Shroder (SWS) did both VAL and TYP,
  They had a similar 64-bit ALU and bus structure.
  It was called a "Monument to MSI".
  Steve was High School friend of Mike Devlin, their 1st hire.

- Mark Frappier (MSF) did FIU took 128 bits from Mem,
  Isolated fields from 1-64 bits,
  dealt with fields that crossed a 128 bit boundary.
  Mark worked with me at Data General.
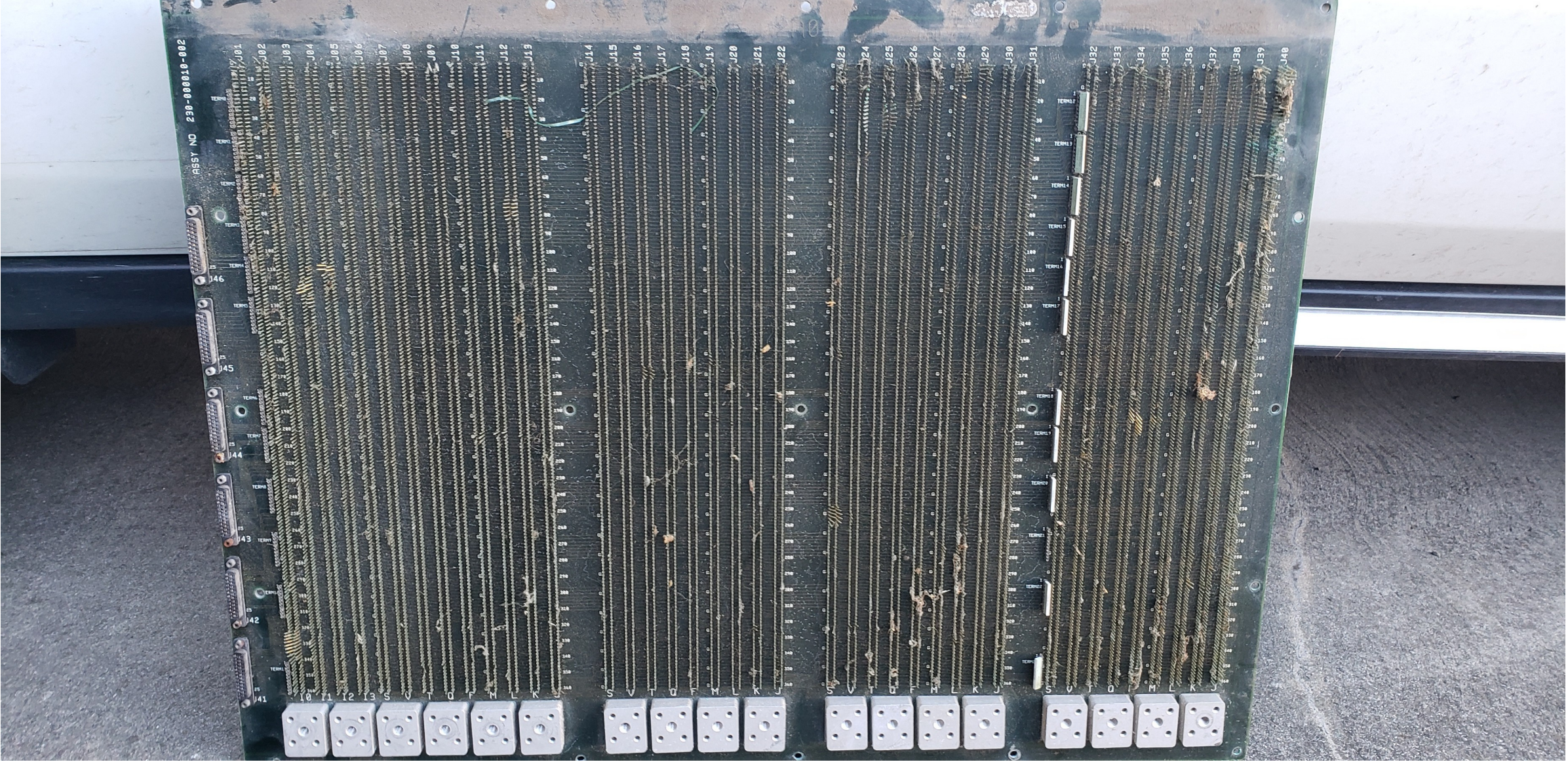 1st occupant of "the Massachusetts Halfway House"

SEQ, SYS and IOA boards

- Ed Paluch (EJP) did SEQ – microprogram Sequencer
  Writable Control Store

- Jim Wilson (JAW) did SYS – multiprocessor arbiter, Memory ECC

- Dave Bernstein (DHB) did IOA, produced a Unibus
  This was amazing considering he did have other "unreal work"
  as VP of Engineering.
  ALL managers at Rational did "real work". We managed by example.

- Chris Jacques (CJJ) did Expmon and 8051 interpreter and Daisy tools.
  Every Hardware team needs a software engineer.
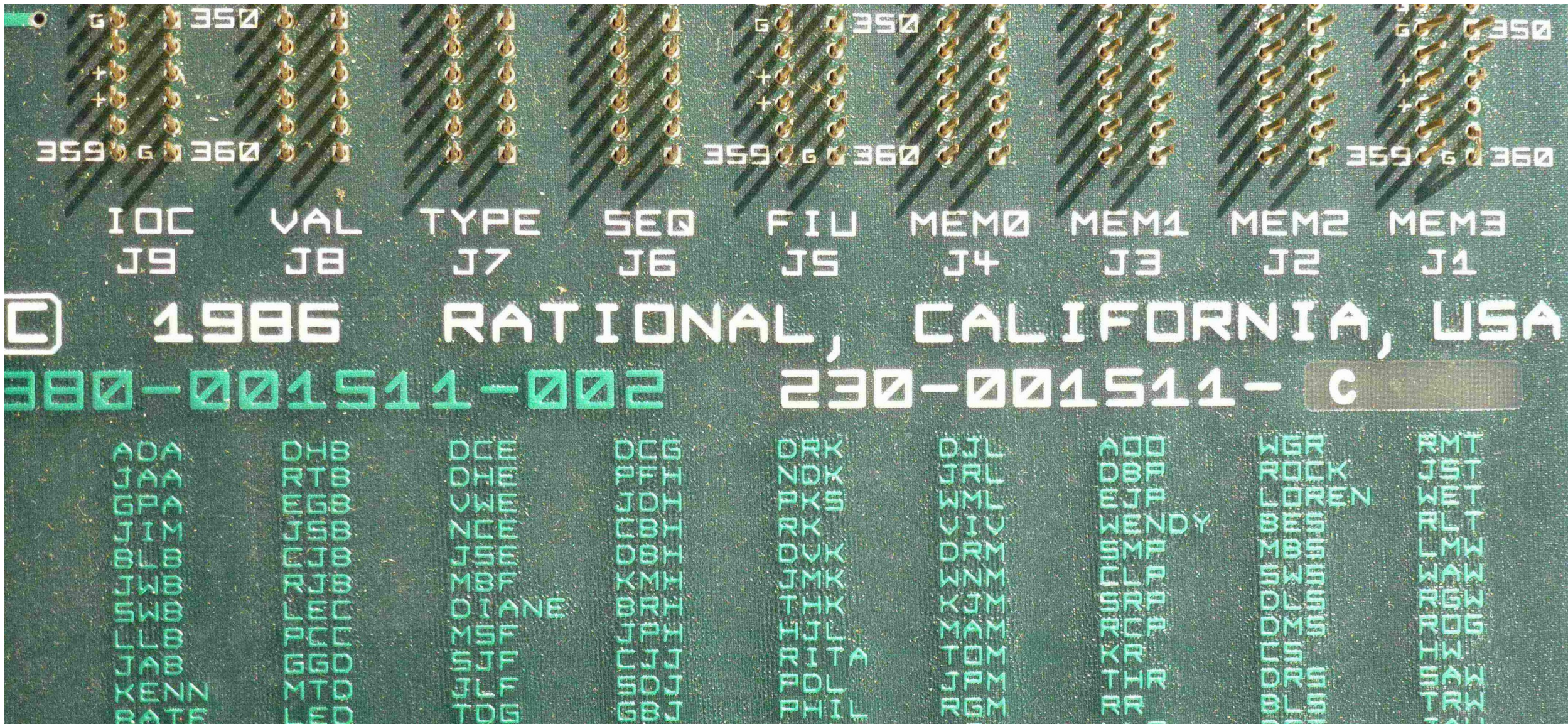 I worked with Chris at Data General on the microEclipse IC.

Series 100, 200, 300 and 400

- Series 100 – 1983 Quad Processor, Massive machine
  Mike Devlin and I could barely tip it as required by UL tip test.
  Price $1Million

- Series 200 – 1986 Punted multiprocessing, PDP-11
  Wayne Meretsky designed IOC with Motorola 6800 processor.
  Wayne was from DG and a resident of "Massachusetts Halfway House"
  Ken Barton was hired from Tandem to do Mechanical design.

- Series 300 – 1988 "Skin job" much smaller package, updated IO devices

- Series 400 – 1990 Upgraded Memory to 32Mbytes, smaller package
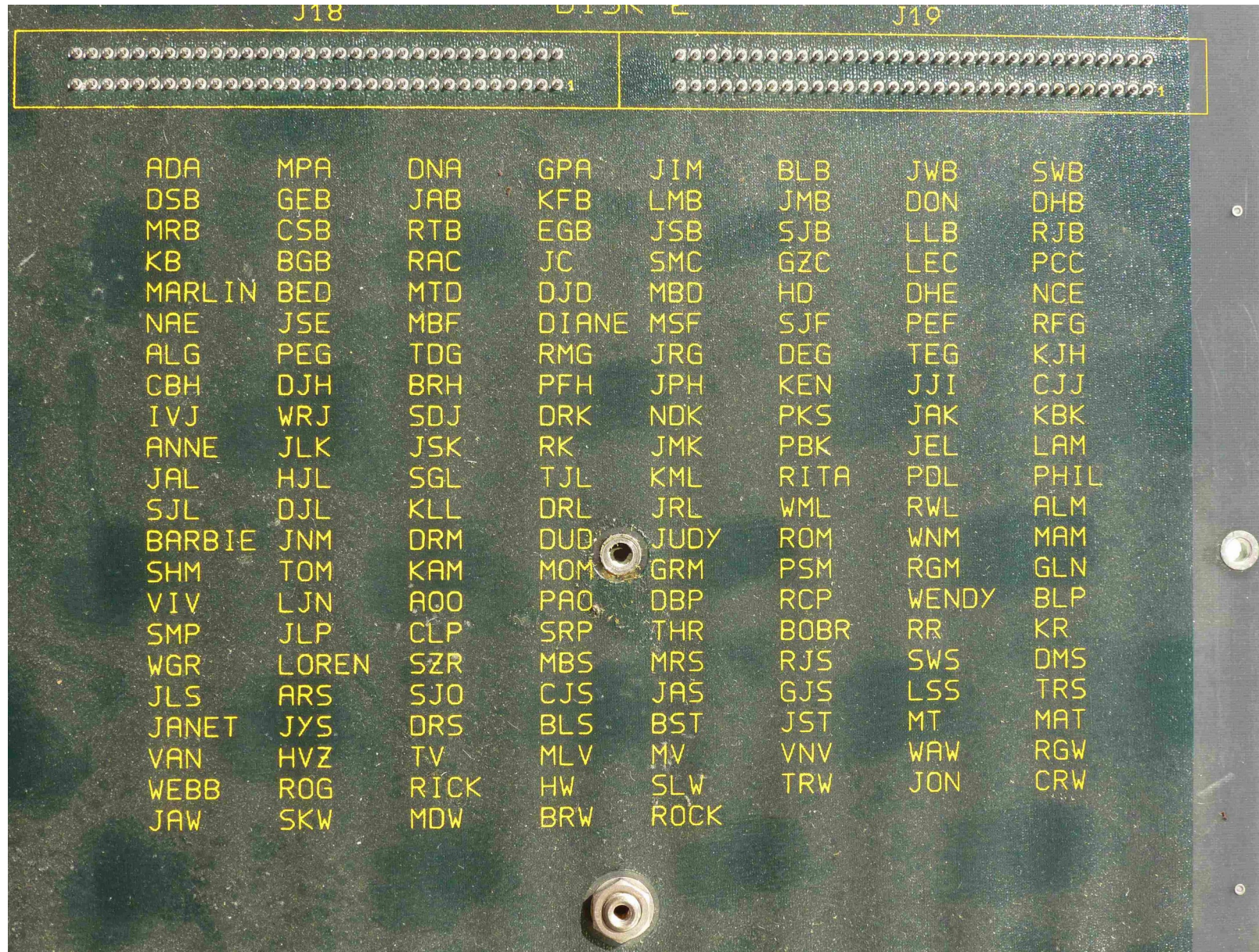 used Exabyte tape rather than Mag Tape drive

R1000 Backplane

Series 200 Initials

G 350   359 G 360   G 350   359 G 360   359 G 360

IOC	VAL	TYPE	SEQ	FIU	MEM0	MEM1	MEM2	MEM3
J9	J8	J7	J6	J5	J4	J3	J2	J1

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IOC	VAL	TYPE	SEQ	FIU	MEM0	MEM1	MEM2	MEM3
ADA	DHB	DCE	DCG	DRK	DJL	ADD	WGR	RMT
JAA	RTB	DHE	PFH	NDK	JRL	DBA	ROCK	JST
GPA	EGB	VWE	JDH	PKS	WML	EJP	LOREN	WET
JIM	JSB	NCE	CBH	RK	VIV	WENDY	BES	RLT
BLB	CJB	JSE	DBH	DVK	DRM	SMP	MBS	LMW
JWB	RJB	MBF	KMH	JMK	WNM	CLP	SWS	WAW
SWB	LEC	DIANE	BRH	THK	KJM	SRP	DLS	RGW
LLB	PCC	MSF	JPH	HJL	MAM	RCP	DMS	ROG
JAB	GGD	SJF	CJJ	RITA	TOM	KR	CS	HWS
KENN	MTD	JLF	SDJ	PDL	JPM	THR	DRS	SAW
BATE	LED	TDG	GBJ	PHIL	RGM	RR	BLS	TRW

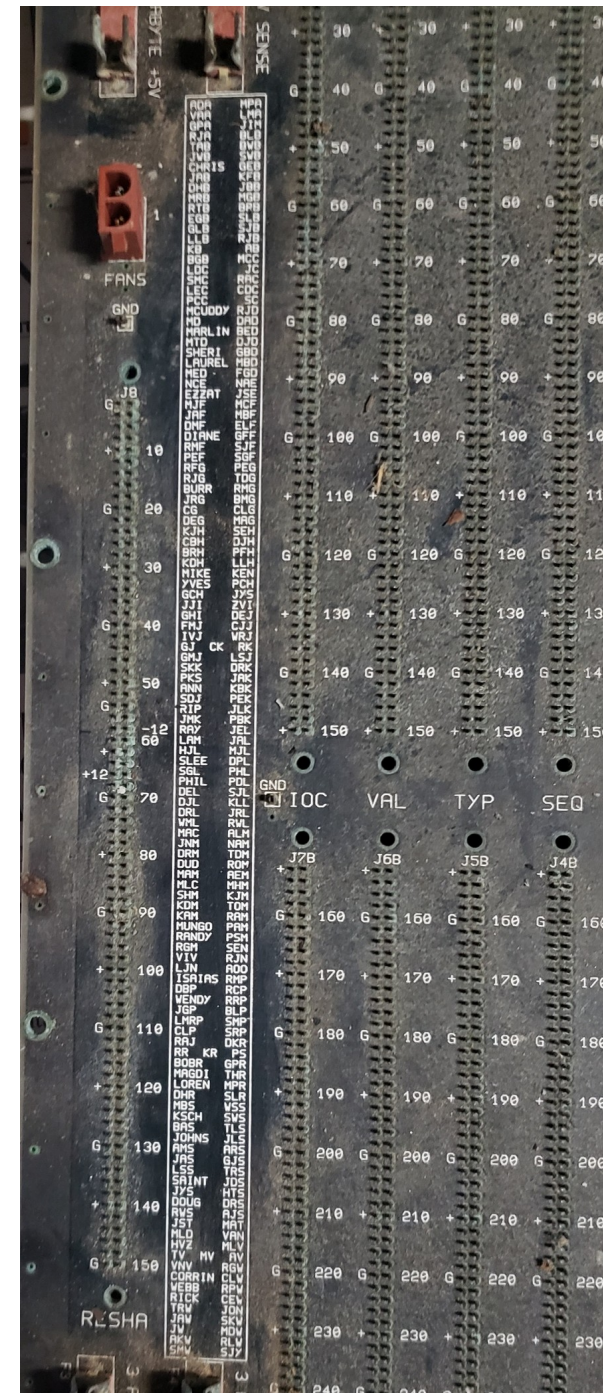# Series 300 Initials

Series 400 Initials

Thank you for this opportunity

Questions?