Meeting at IBM, Feb 4, 1957, Poughkeepsie, N.Y.
Monday am.

(Dunwell): Report on Status of Components.

- circuits, components etc. are going ahead well — a little bit ahead may get well ahead in next few mos.
- no. of transistors is building up. a few hundred of p-n-p's. Can make them on pilot plant basis. can estimate yields well Will have 30 people in Feb (now have 15, none on Jan 1). Control is tough problem.
- by mid-summer will have main plant manufacturing —
- n-p-n transistors — a small no. of people can make them now — plan to expand to equal p-n-p's in next few mos (circuits will use about equal nos. in machine.)
- core drives: can make a minimum drive now. not as far along.
- are using "end of life" transistors in data-flow circuits now - OK for research.
- are laying out new data-flow models now. to answer specific questions
- General Nature: aiming toward a new class of machines.
  I/O parts are of general use.

1. — Magnetic Tapes:
2. — High Capacity Disk Mem.
3. other I/O devices.

Basic problem of computers I/O talking to each other — a general problem of adapting & converting — telephone lines, etc. "Exchange" mechanism

"Exchange" has been spelled out, want to start layout in 30 days.

- requires fewest no. of components, + smallest demand on components.
- need of variety is smaller.
- is a separate problem from main calc.
- Hope to get feedback on rest of machine design.

Agenda:

1. Disk room — Tue AM
2. Tapes — Tue AM
3. Exchange — Mon PM
4. Word Format
5. Arithmetic
6. Addressing

Word Length: 64 bit is very desirable from IBM's point of view

Instructions — can have data memory of less than 64 bits. maybe ?

(Buchholtz) 1. a power of 2 is desirable — completely general walking on bit basis is possible (may have non-zero start — should be continuous.)

2. Editing in stored program — extensive bit manipulation — logical work on bit basis.

3. main disadvantage (cost of extra bits)

4. all stages are the same in all components (no short or long units)

5. make mechanisms in "exchange" easier. addressing mechanism.

E.g. a card is a one dimensional string of bits — doesn't need to be 2 dimensional. The whole memory is string of bits

101100.110011 = bit no.

word addr. bit location

speed:

carry propagation goes as $e^{(\text{No. of wds})}$

carry collapse will be detected on add anyway & dir.

governing mechanism to store away only significant figures ie. don't use 48 bits when only 20 bits.

data: 54 bits is about what we would want for precision.

We agree on 64 bits:

to address separate bits a need 27 bits. — but not needed for all words.

(Carlson)

Secondary Addr	X Addr (geom. addr)	Base addr
12 bits	12	16

(Pomerene) adding 2 20 bit nos. 60 to 80 μsec depending on no. of carries.

(Griffith): have allowed 200 μsec for whole indexing in timing charts.

(Brenwell): Rule for adding indices: 100 μsec per no. added (not first one)

this is time to do the addition after selection. assume nos. in U.F. reg.

question of bus system - not decided how it will work -

Monday PM

(Buchholtz) I/O Exchange :

for input output.

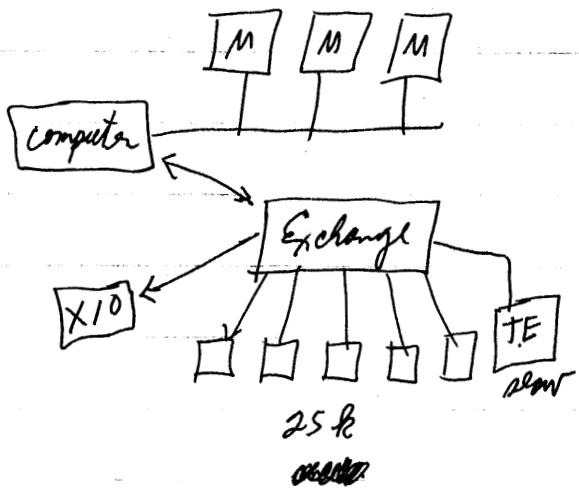
1. Efficient on-line operation (using timing data)
   - memory acts as large buffer.
   - programming stored in main memory - central functions
   - real time applications
   - less operator intervention.
   - fewer errors + more rapid corrections.
   - off line by tape systems (both near + remote)
2. Central Editing,
   - in computer by stored prog. - gives speed and variety.
   - do away with most ~~of~~ switches — console is another I/O unit
   - reliability - checkability,
   - stored for long periods, etc.
3. Large Tape Reservoir,
   - automatic reel changing, rapid changeovers of prob
4. Remote terminal Equip.
   - telephone line transmission. (rel. low speed - cost speed)
   - to get user out of way of machine "desk calculator" usage.
5. Multiplexed low speed units.
   - a must for real time appl.
6. Flexible character code translation different "bite" size.
   - from diff machines - tape codes, cards, - - by programming, not by machine
   - decimal work in I/O computer.
7. Standard I/O Connections. (8 bit "bite size".)
   - any special device can be put on with a converter.

727 type e.g. converting 6 bits to 8 $\begin{matrix}=_6^6\\=_6^6\end{matrix}\}\{=\begin{matrix}8\\8\end{matrix}$

8, Character Sensing.

-typewritten maybe handwritten

(Herb —)



Medium Speed

1. Tape (727 Type)
2. Highspeed tape (10 times above) — separate
3. CP
4. Punch
5. PTR
6. Doc. reader.

Terminal Equip. (~10 char. per min)

1. Keyboards
2. Typewriters
3. Telephone lines.

High Speed { 25 char/sec to 35

1. H.S. tapes
2. H.S. bulk storage.

will have separate exchange facility

assume 72 bits in words + (maybe 4 or 5 more bits for control)

computer will forward I/O orders to Exchange.

Exchange matches speeds of units,

" " word size between units,

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1. Impedance match
2. Information size match
3. Simultaneous opn. of devices.

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1. Instructions
   - read
   - write
   - control
2. Data Words — Information
3. Control Words

(one word in mem. for each I/O device) → control Wd. memory. | H.S. Memory Data Wds ← memory in exchange. (1 μsec cycle)

Exchange Memory.

↓ read out + shifted right 8 positions + written back

reg. | | | bits counter

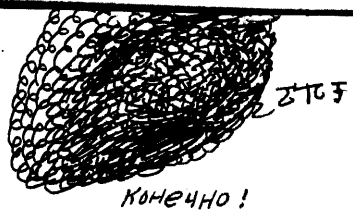
+

device → Word count

(or cycle counter)

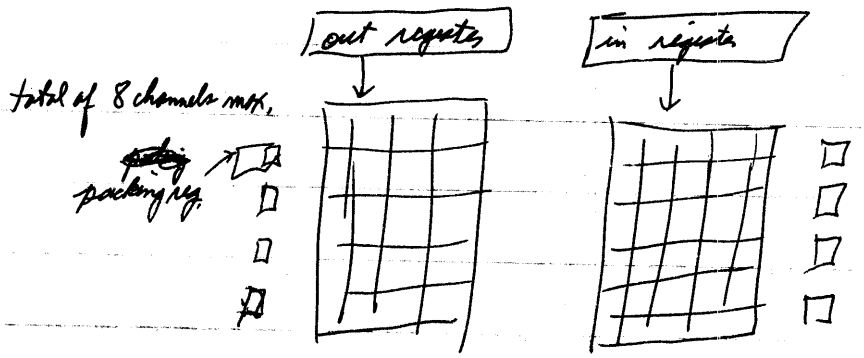
?? !

quantities for control { cont. wd; data Wd addr.; word count; control wd addr.



Multiplexing:

crosspoint core switch. (64 devices) can be connected permanently)



← also holds one bit for each unit.

Instruction: Read 0200 Control Wd. Addr.

decoder picks out row in crosspt. switch, and channel which is open, sends signal.
put control wd in control wd register,
call in control wd. from main mem.
set cycle count.

64 bits: 20 mem. addr, control
15 word count
20 data wd. addr
1, grouping + distribution
1, checking flag.

maybe status indicator

Grouping several wds to make a record on tape.

can handle about one opn

Low Speed devices: (256 units simultaneously possible)

- Scanner
- communication

The "Times 10" tapes.

The information wds. are not stored in Exchange Mem.
full words are entered in bus 4 × 10 channels

sharing isn't possible at these speeds.

low speed 1. Characte by characte
2. bite by bite
3. word by word

Disk: same logic as (×10) tape

individual registers for addr. & counter

question of read backward
error stopping of tape in middle of record

checking.

~~SUMMARY:~~

1. Basic Exchange:
   - 64 units
   - 8 simultaneous channels.
     card readers, punches, printers, communication tapes.
     disk unit (low speed type, block) — program storage?

   orders: Read / Write } control (about of) word indexing
   control + (bits which pass thru exchange to unit.)
   copy control wd.

2. Low Speed: - 256 units (all simult.)
   key board, typewriter, telephone lines, 026 (?)

3. "Times 10" tape

4. { High speed tape, High speed disks } (times 100) 80 units (4 simultaneous)
   1 in, 1 out simult.

   (about 10 million words per tape. with auto reel changing)

Tues A.M.

Report on Disk Memory, San Jose Labs.
(Bill Goldberg?)

Present RAMAC File:

24" disks 0.4" between 1200 rpm.

100 disk surfaces. 2 heads for whole file,
film of air lubricant - pumped out from head.

density: 100 bits per in., 20 tracks per in. bits polarized parallel to disk.
surface: red iron oxide on Al disks.
erasing is wide, writes narrow. self clocking signals.
Head positioning: are driven by a servo, mechanical detent.
Time: less than 1/sec max. 0.5 - 0.6 sec average

5 100 character records per track (10 records without moving heads are available.)
total 5000000 characters.

For STRETCH:

36 disks (72 sides) with 72 heads. air compressors not needed with new design using viscosity of air. 2 HP motor to drive disks.

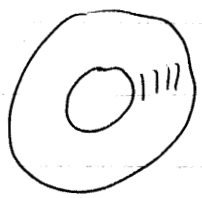
Spacing 0.3" apart 24" disks same no. of bits per radian about 2 to 1 variation

Expect 205 bits, 50 tracks per in. density. (could go to more but this is safer for extended clocking.)
vertically polarized bit arrangement, recording head requires soft iron return path.
iron oxide on iron disk.

Parallel read-out from 72 heads. 64 info bits. 8 checking bits

1800 rpm. 250 k pulses per sec output.

2nd set of heads. one moving from track to track while other is reading.
odd on one side, even on other.
4 blocks of 2048 bits each 256 blocks per track, 4 blocks per track



← 256 tracks 4 blocks per track 2048 bits per block

2097152 total.

60-75 msec average access time

20-25 milisec from track to the next.

0.10 sec any track to any track maximum

Transistorized same as balance of STretch.

(1024 addresses only)

block random access. must start at beginning of block?, must take whole block?? not.?

both heads must be in same status (both read or write)

100 μs (25 bits width) gap between blocks

Writing a block, erases whole block even though only part of block is written.

250,000 wd/sec 4 μsec/wd. are we sure this is speed we want?

what about 8 μsec/wd?

⇒ go over this timing question again. wrt. speed.

High Speed Tapes:

goal: 100 x (727 system)

5000 bits/inch 300" per sec. (25' per sec)

comes out ~ 200 *(727)

~8 μsec per wd. ?

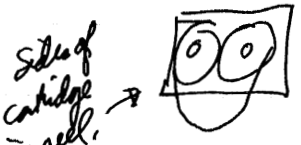
Start & Stop 4 msec reverse in ~same time.

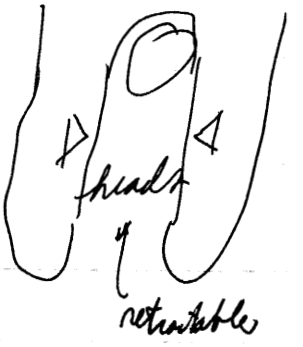
Error correcting code not decided as to type. single correction. multiple detection.

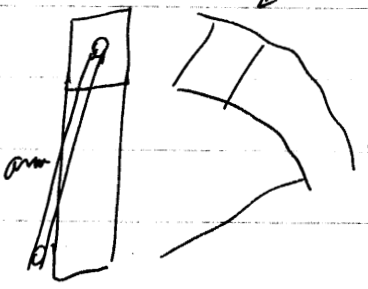
separate read & write heads attached together. - com clock, etc.

Automatic cartridge reel changer. ~ 10 sec change time

one type:
cartridge: sealed against dust.

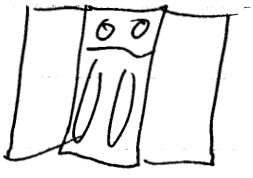






16 reels can be held
can replace 8 at a time or 1 at a time

another type: 2 units back to back



← shift always either machine can call on one of 32 reels.

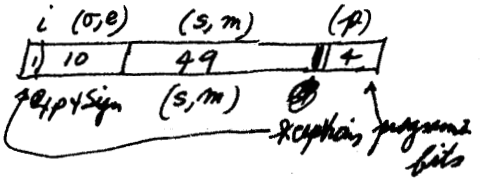
cartridge 18 lbs. 2400 ft. long 2" or 2½" wide.
22 tracks in each direction
no read backward in usual sense read one track forward, other track backward.
fixed speed - forward or back.

(Carlson)

(1) Number System
(2) Arithmetic
(3) Addressing.

(1) Nos: Range: (Scaling)

Precision: (Multiple precision)



sys: ± 512 (10^{154}) base binary.

one trigger for each, (set on generation)

1) m cancellation (0) } call 0.
2) e large neg (0) }
3) div by (a) $\frac{X}{0}$, (b) $\frac{0}{0}$ or $\frac{\infty}{\infty}$ (∞) } call ∞.
4) e large pos (∞) }

Breakin: (or before)

operations: (∞ terminates)

i = 1 normal s = 0 for 0
0 exception 1 to ∞

(2) arith:

(Sweeny) A [ ] [ ] [ ] B [ ] [ ]

↑ one additional bit for single precision

use B only for floating ops. double precision.

Dunwell

19 bits for order field. minimum

IBM needs more guidance
- problems and logic of I/O.
Tapes: Read Backward, etc?
Disks: - use, addressing, timing, etc?

question of nos. of registers, details of engr., etc
we won't know for 30-90 days. ——————————

Wed AM.

(Buchholtz) topics for discussion

previous list:
1. Performance
2. In-out
3. Data Format, Indexing, addr
4. Auto. & Data Mgt.
5. Auto. Prog.

1. Exchange — IBM will prepare writeups.
2. External Memory. — LASL will prepare writeup.
3. Input/output
   regular commercial
   keypunch for auto prog.
   plotting., etc.

⇒ Would like a writeup on use of external memory — 3 dim problems
disk, H.S. tapes, present RAMAC.
Exchange committee in 30 days or less.
question of Type of I/O IBM will want to concentrate on in '60., etc
4. addressing of memory.
5. Indexing.

(question of going above 32000 mem. what is best way to)
attend & balance Ram, random access, etc?
I/O computer next coming up.