Lee-02

"The notion of "happens before"
and we introduced the notation.

A → B >> "A happens before B"

means
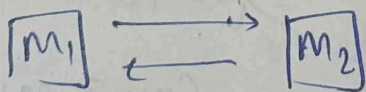
A could have been cause for B
but
B could not have been the cause of A

⇓

and this is very important in
able to reason about how to
debug and design distributed
systems.

In a simple diagram like this.

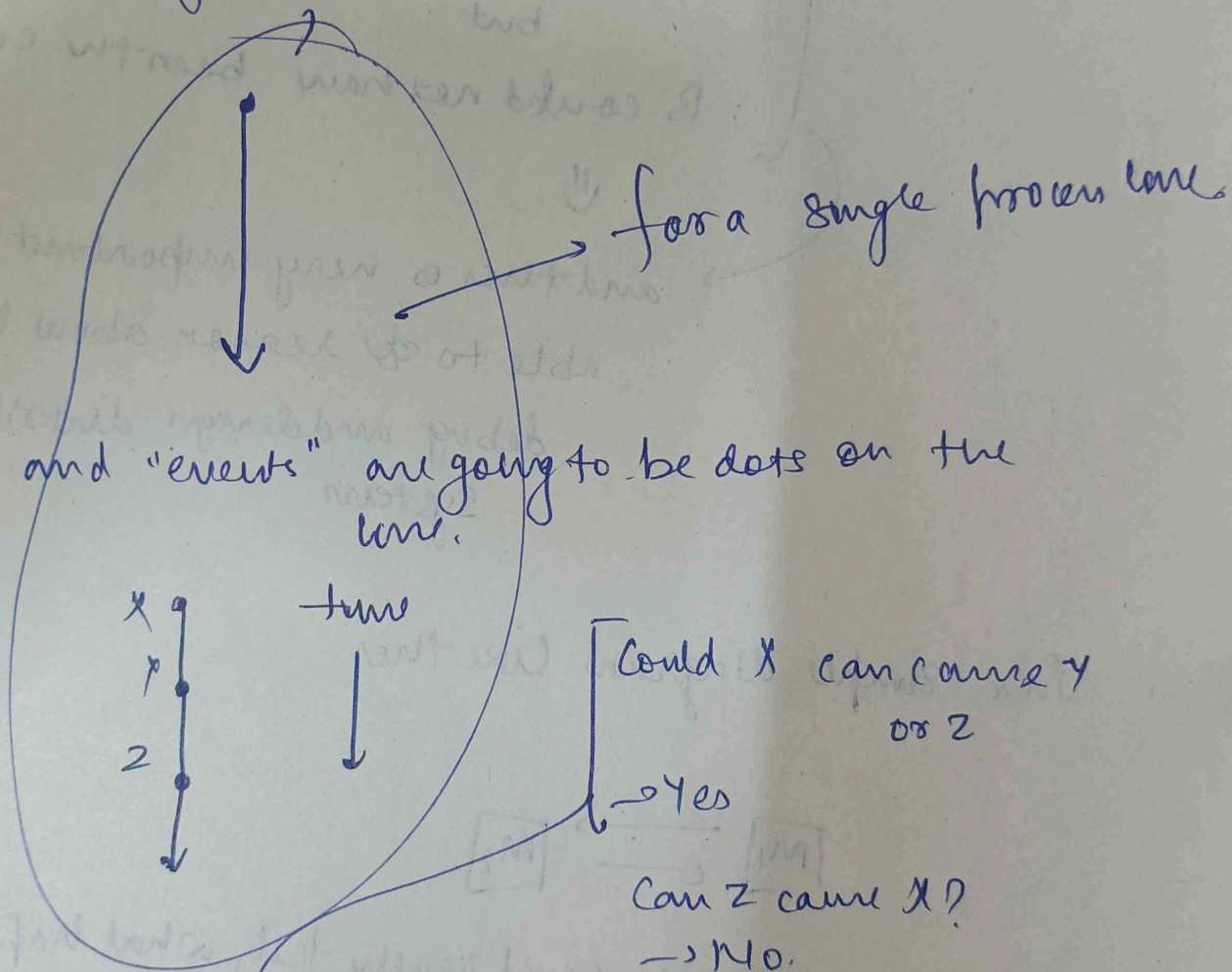$$\boxed{M_1} \underset{t}{\overset{\longrightarrow}{\longleftarrow}} \boxed{M_2}$$

we can't really tell, what happened
before

To isliye humlog ab naye tareeke se
diagram ko represent karenge.

(Lamport) Diagrams

Space Time

→ Idea — we have a notion of a process and the process is just a line with a discrete beginning that goes on forever

→ for a single process line

and "events" are going to be dots on the line.

X time

p

2

Could X can cause Y
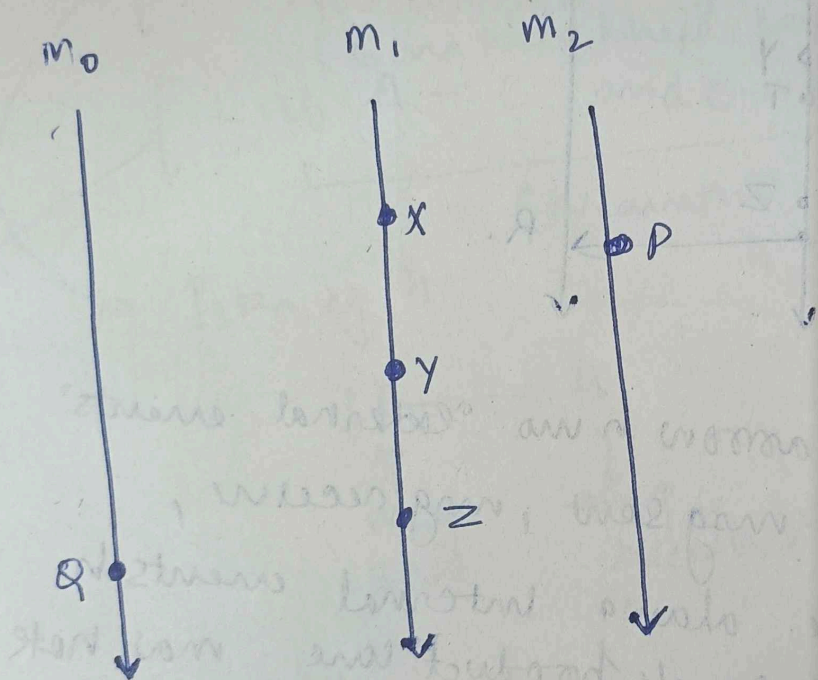or Z

→ Yes

Can Z cause X?
→ No.

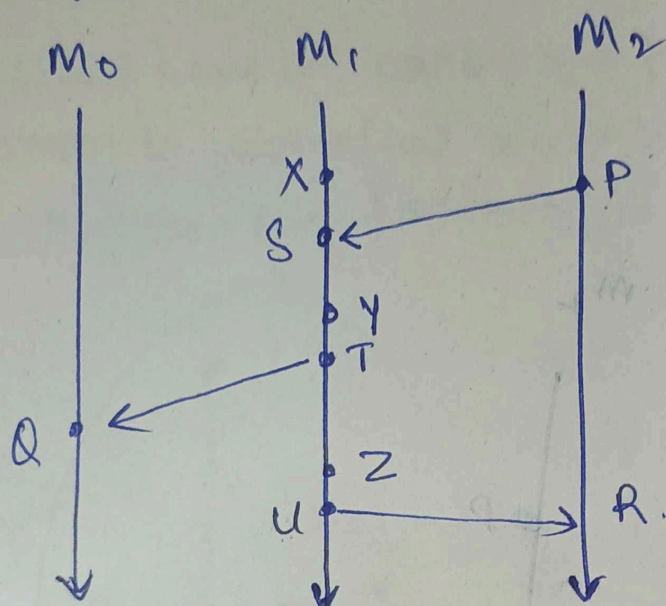but don't know for sure if
X caused Y
→ No

So given an event, and to find out set of events
that might have caused it is look above it on
the line, and i want to know why that
event happened, then something above
on the line would somehow be responsible
for that

Since there machines don't share any memory and
can't read each other's mind,
they have to communicate by sending and
receiving messages,
infact that the only way they can
communicate with each other

"and msg sent and received are also events, infact they are very important kinds of events,

lets add some events

Dekh ye to arrow h wo "external events" h, jaise msg sent, msg receive, pan coke alawa internal events h jo ek single product "care mai. hote rehte h,

Given two events A and B,

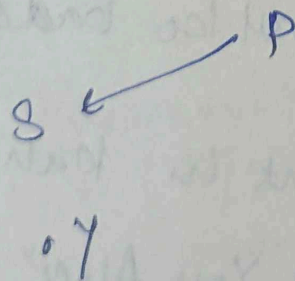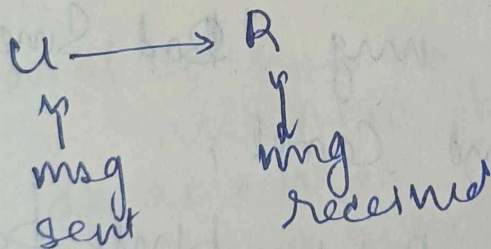we say $A \longrightarrow B$ (A happens before B)

if any of the following is true.

— A and B occur on the same process line with B after A

[— A is a msg send event and B is the corresponding receive.
(bina msg bheje, receive kaha se hi hogd)

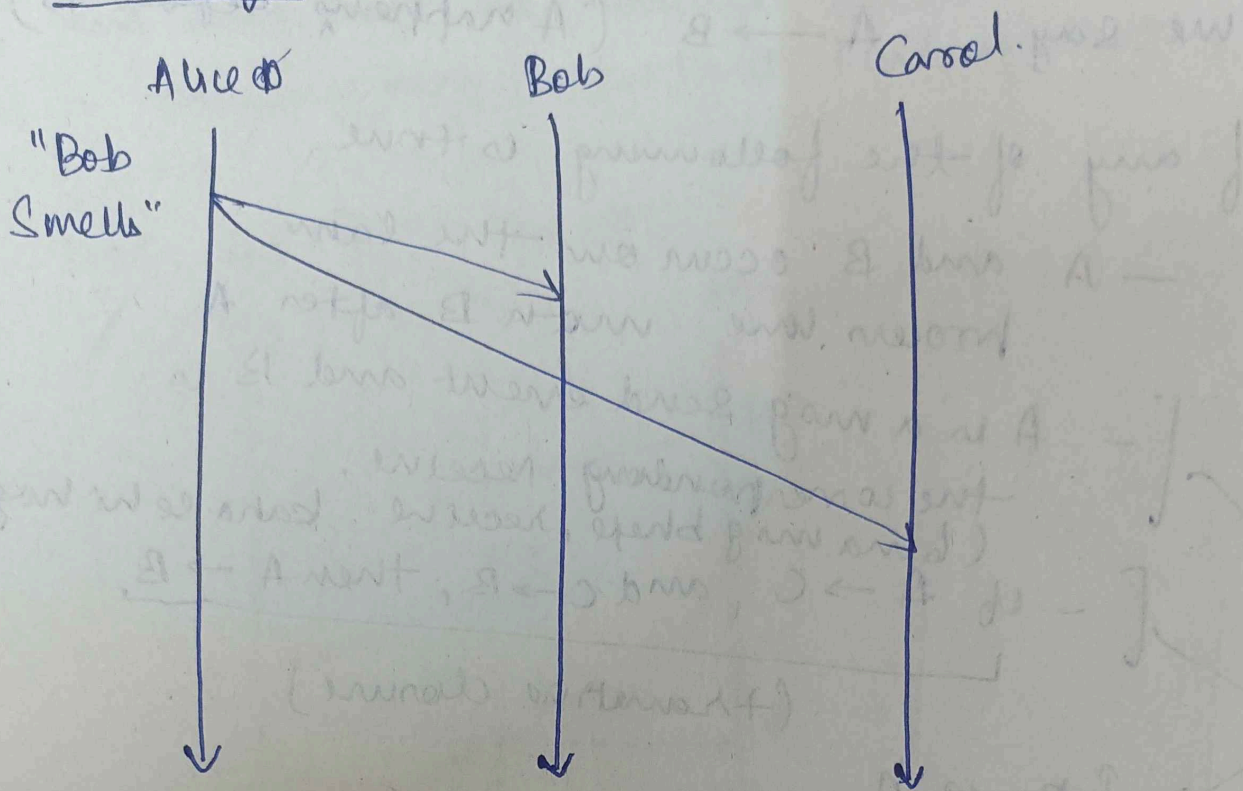[— if $A \rightarrow C$, and $C \rightarrow B$, then $A \rightarrow B$

(transitive closure)

Iska eg $\downarrow$

$u \longrightarrow R$
$\uparrow$ $\downarrow$
msg msg
sent received

P
$S \longleftarrow$

$\cdot \gamma$

$\left. \begin{array}{c} P \rightarrow S \\ \text{and} \\ S \rightarrow \gamma \end{array} \right] \Rightarrow P \rightarrow \gamma$

Another eg :-

Alice   Bob   Carrol

"Bob
Smells"

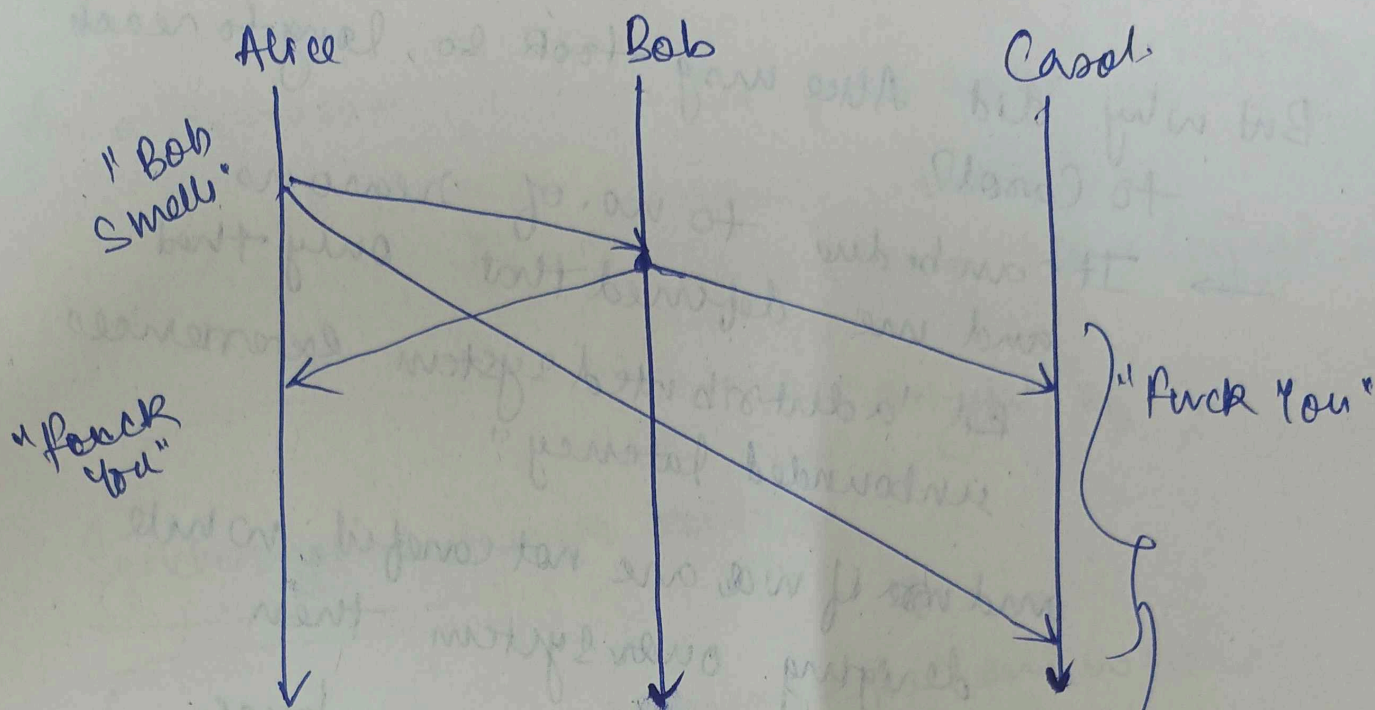Alice Sended msg "Bod Smells" to both.
Bob and Carrol,
Par msg Bob ko phele pahucha
aur Carrol ko badd mar

Bob ne msg dekhte hi kaha
"Fuck You Alice"
aur dono ko bhej diya.

Alice   Bob   Carol

"Bob Smell"

"fuck You"

"Fuck You"

Yaha dekh.

Carol ko Bob ka msg phele aa gaya
aur Alic ka bad mai,
ab aure mai Carol to galat
hi samjhega

This is what called an.
"Causal Anomaly"

So, we are going to talk about how we can
use the "concept of happens before" to
rule out such anomalies

But why did Alice msg took so long to reach
to Carol?
→ It can be due to no. of reasons,
and we defined that only that
ki "a distributed system experiences
unbounded latency".

and if we are not careful while
designing our system then
latency will lead to bugs.

$$\Downarrow$$

This led us to Something called
"Network Models"
$$\longrightarrow$$

→ It would really make life easy if we knew
that there was a some fixed amount o
time that it took for msg
to get from alice to
carol.

Aro a network Jaha mujhe pata hobr
ek ursg to receiver tak jane
mai ktna time lagega une
(A type of

Synchronous netwoor kahte h.

↳ Asynchronous netwoosk ko one where
there exist an n s.t,
no msg takes longer than n unets.
of time to be delivered.

Asynchronous network model

→ A asynchronous network ks just a.
netwosk where there excets no
such 'n'.

"Distributed Algo" → Lynch.

State and Events (kaafi kuch lehaja o dekhunge
napau → around 5 min)
around → 32? on

$Q \not\to R$ and $R \not\to Q$

(Causa Situation, Jaha I can't decide which
happened before)

then | Q and R are (concurrent)

$Q || R$

(notation of
concurrent)

Partial orders

— a set S, together with a
binary relation, usually, but not
always, written like $\leq$,
that lets you compare
things from S, and has
there properties:

— Reflexivity
$\qquad \forall a \in S, a \leq a$

— **Transitivity**:

$\forall\ a, b, c \in S$,

if $a \leq b$ and $b \leq c$
then $a \leq c$.

— **Antisymmetry**:

$\forall\ a, b \in S$, if $a \leq b$.
and $b \leq a$ then
$a = b$

So, if we are going to

~~Twoe~~ So, there are the properties that have to be
true for a partial order

I just claimed that "happen before" is a
"partial order",
but its weird.
Like this holding for natural nos. make
sense.

but can an event b.

Cek how can "Event A can happen.
before event A"

So, "happen before" relation is not reflexive.
It is irreflexive Partial order.