Hazard Mitigation: Leveraging State Diagrams

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Landauer Medical Physics

A Hazard Mitigation Strategy

- Identify hazards
- Characterize system by its states and state transitions
- Prevent transitions to harmful states

Advantages

- Systems approach
- Hazards are the focus and are addressed directly
- Incomplete knowledge is useful
- Whole classes of hazards can be prevented without an exhaustive list
- Process map is implicit
- Policy and Procedure are framed

STATE DIAGRAMS

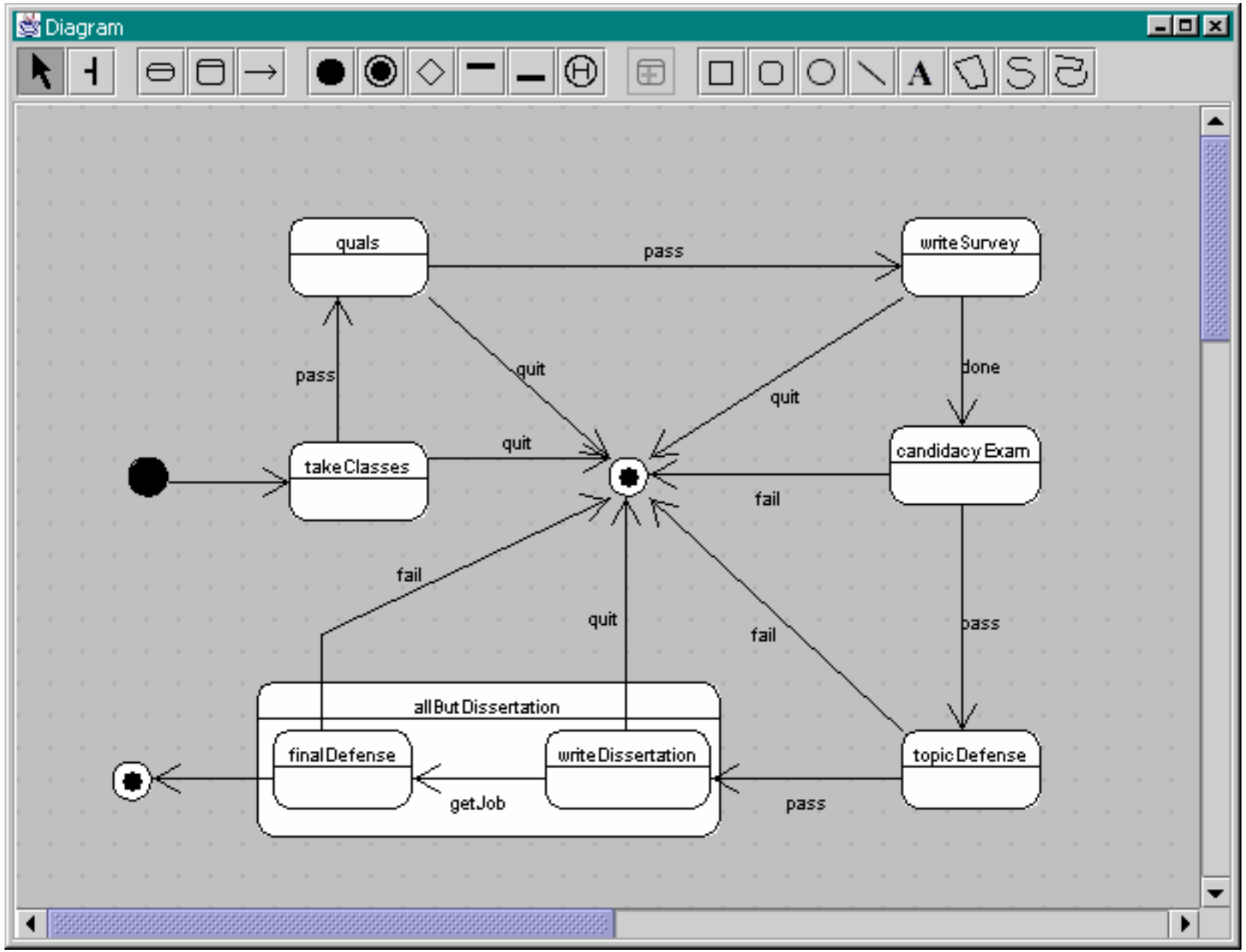
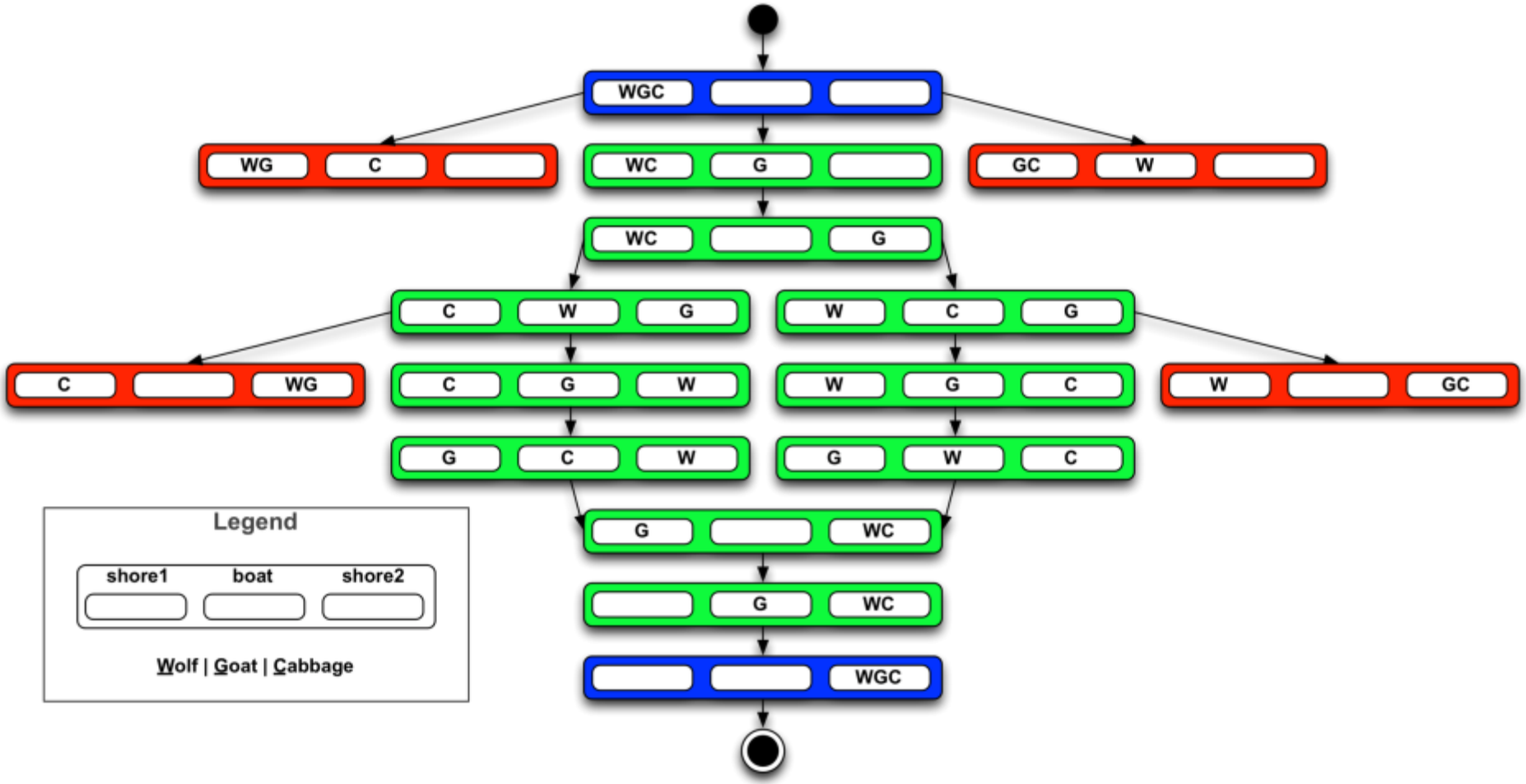


Diagram
quals
pass
write Survey
pass
quit
done
quit
take Classes
quit
candidacy Exam
fail
fail
quit
fail
pass
all But Dissertation
final Defense
write Dissertation
topic Defense
getJob
pass

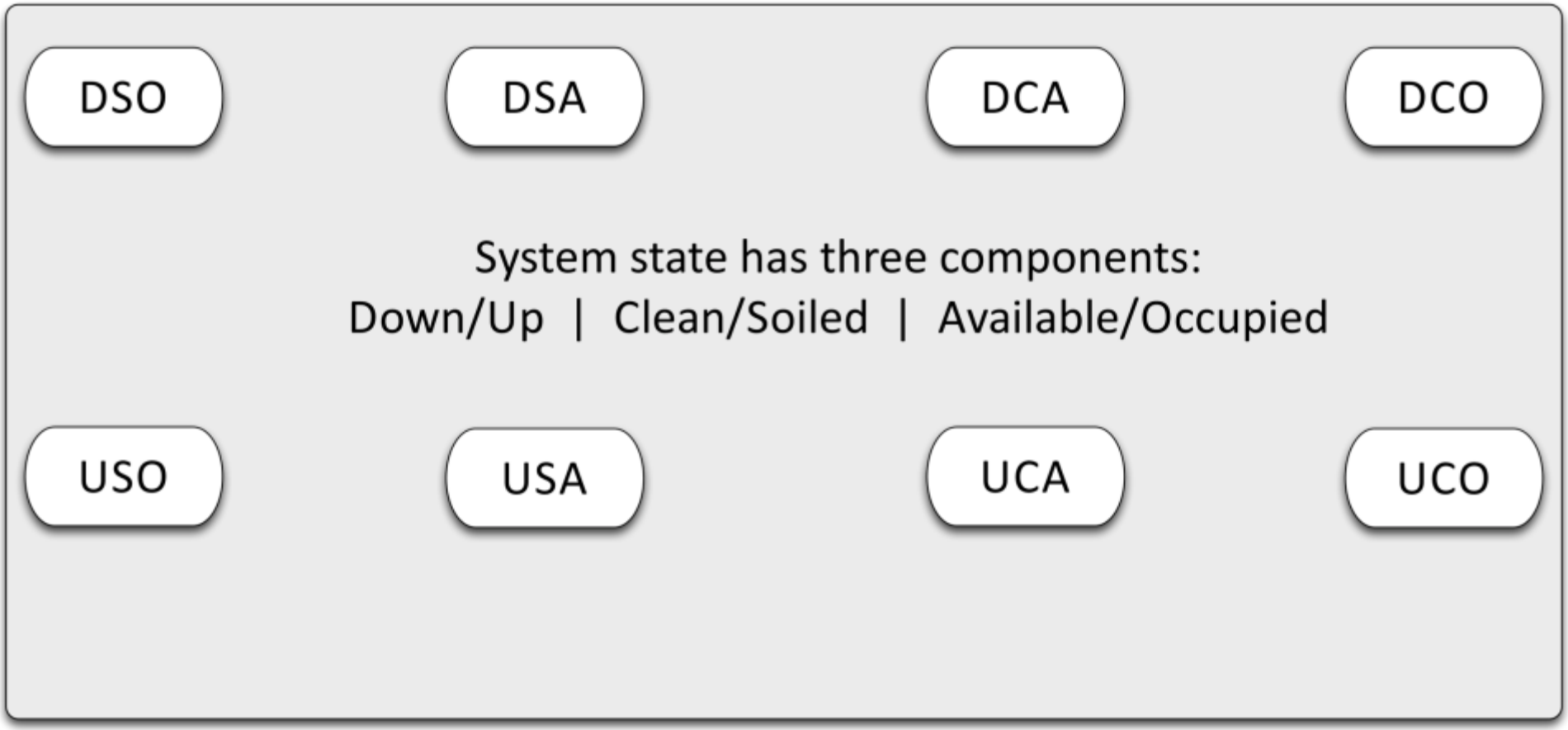

WGC
WG C
WC G
GC W
WC G
C W G
W C G
C WG
C G W
W G C
W GC
G C W
G W C
G WC
G WC
WGC
Legend
shore1 boat shore2
Wolf | Goat | Cabbage

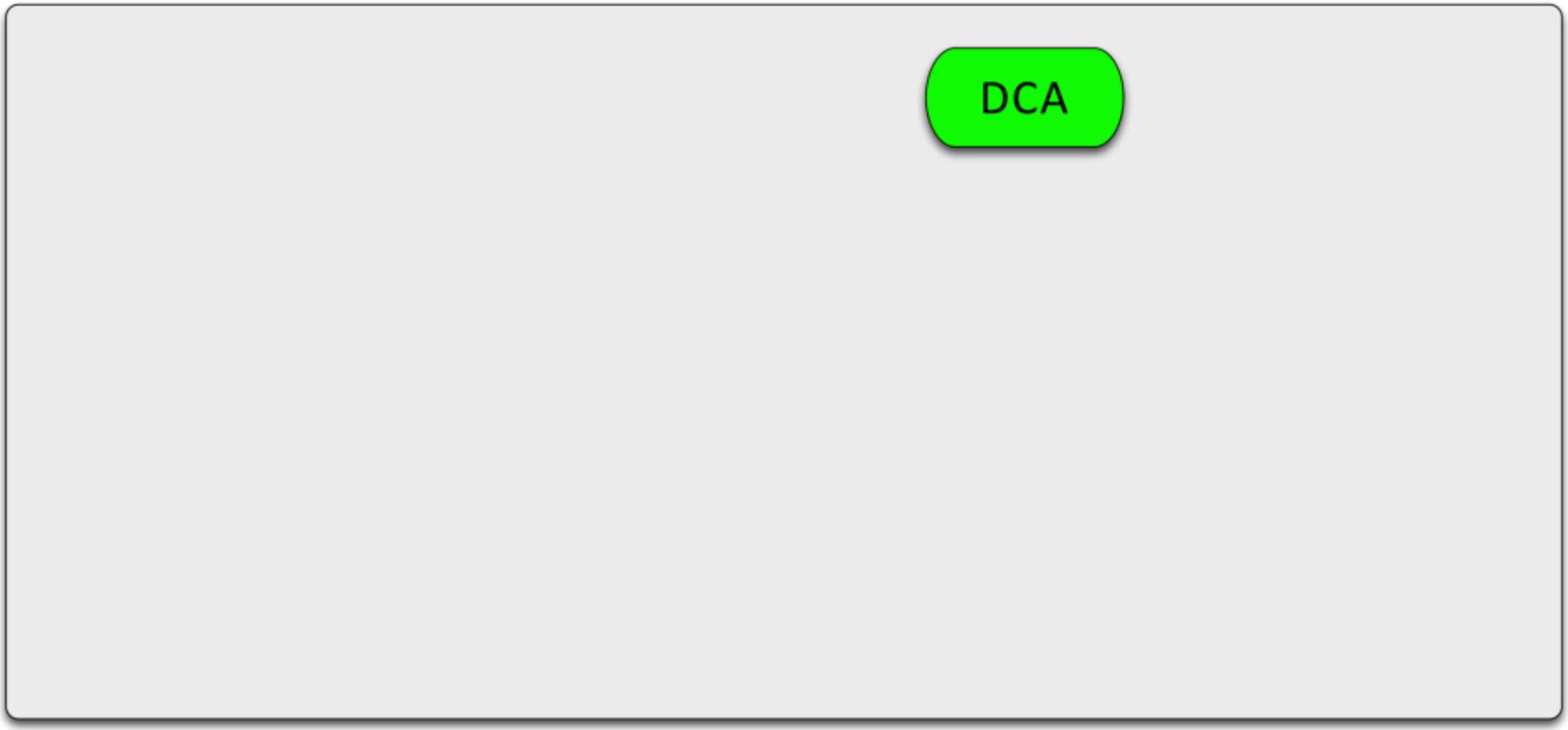
SAMPLE HAZARD ANALYSIS

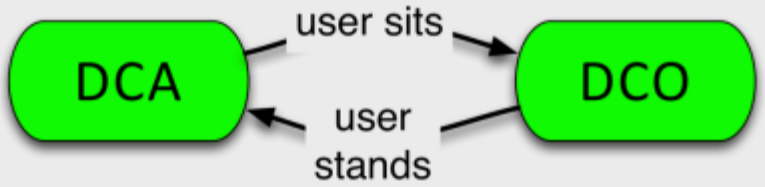
The toilet seat problem

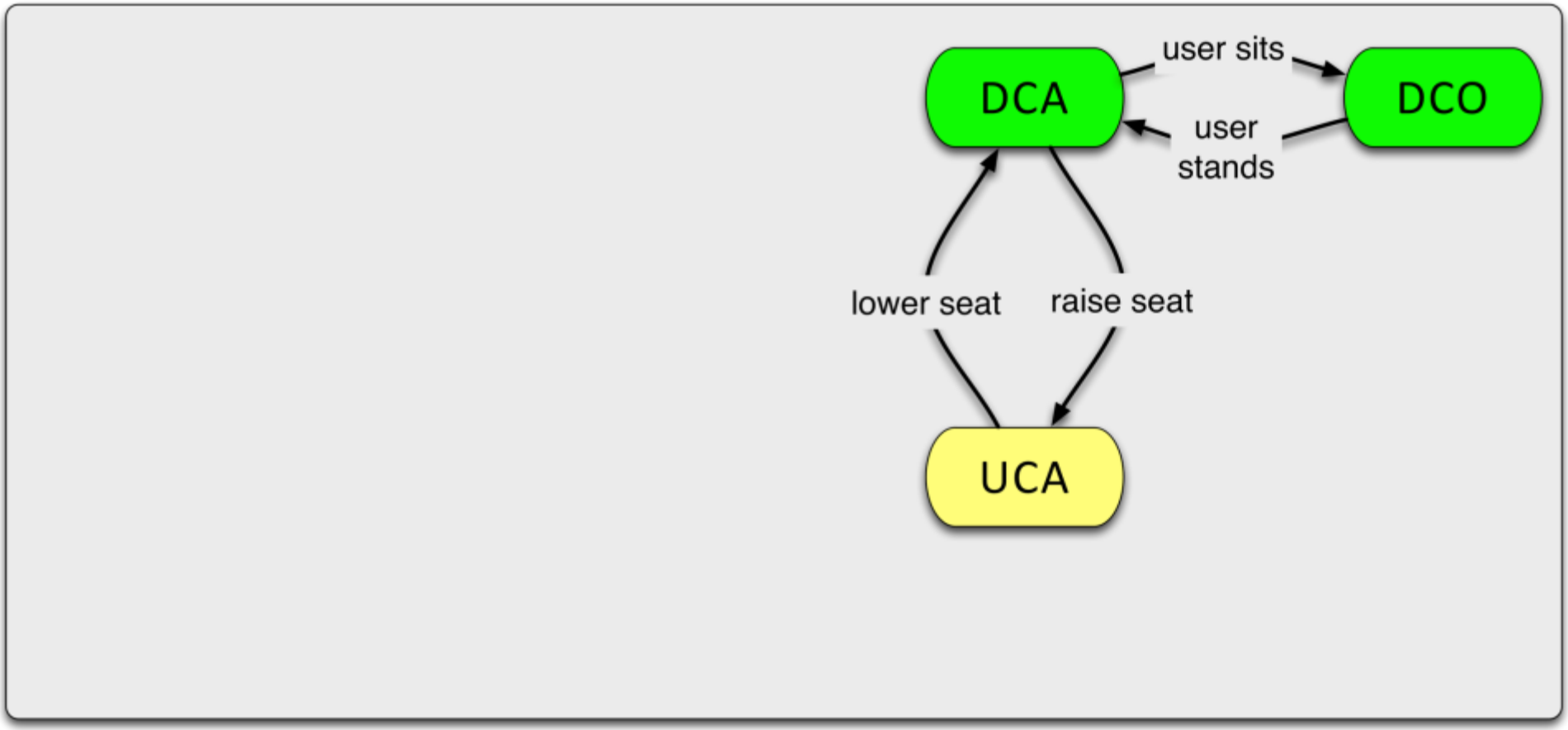
Hazards to be considered:

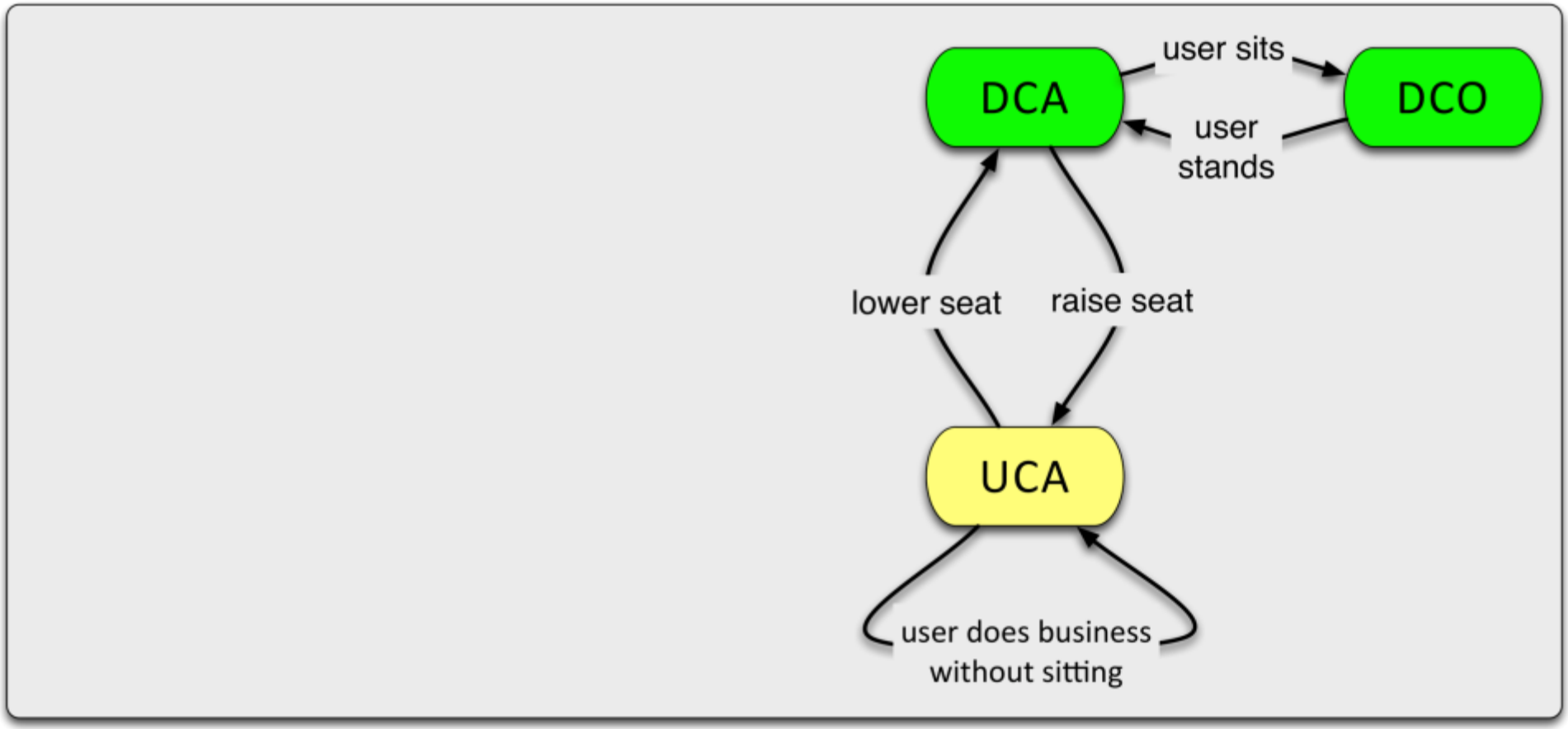
- Physical - Sitting on the cold, hard bowl rim
- Sanitary - Sitting on a pre-moistened seat
- Emotional - Domestic strife

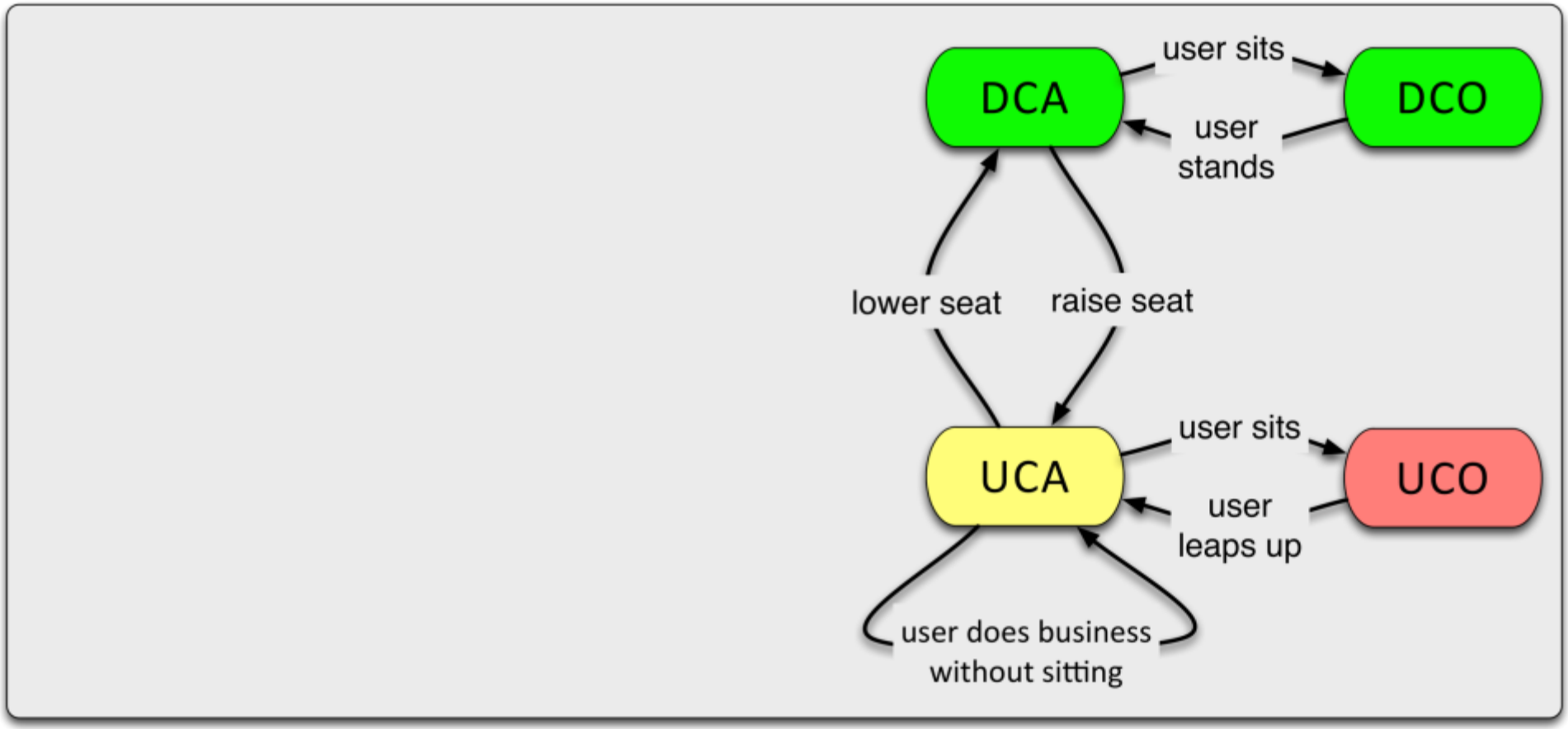

DSO
DSA
DCA
DCO
System state has three components:
Down/Up | Clean/Soiled | Available/Occupied
USO
USA
UCA
UCO

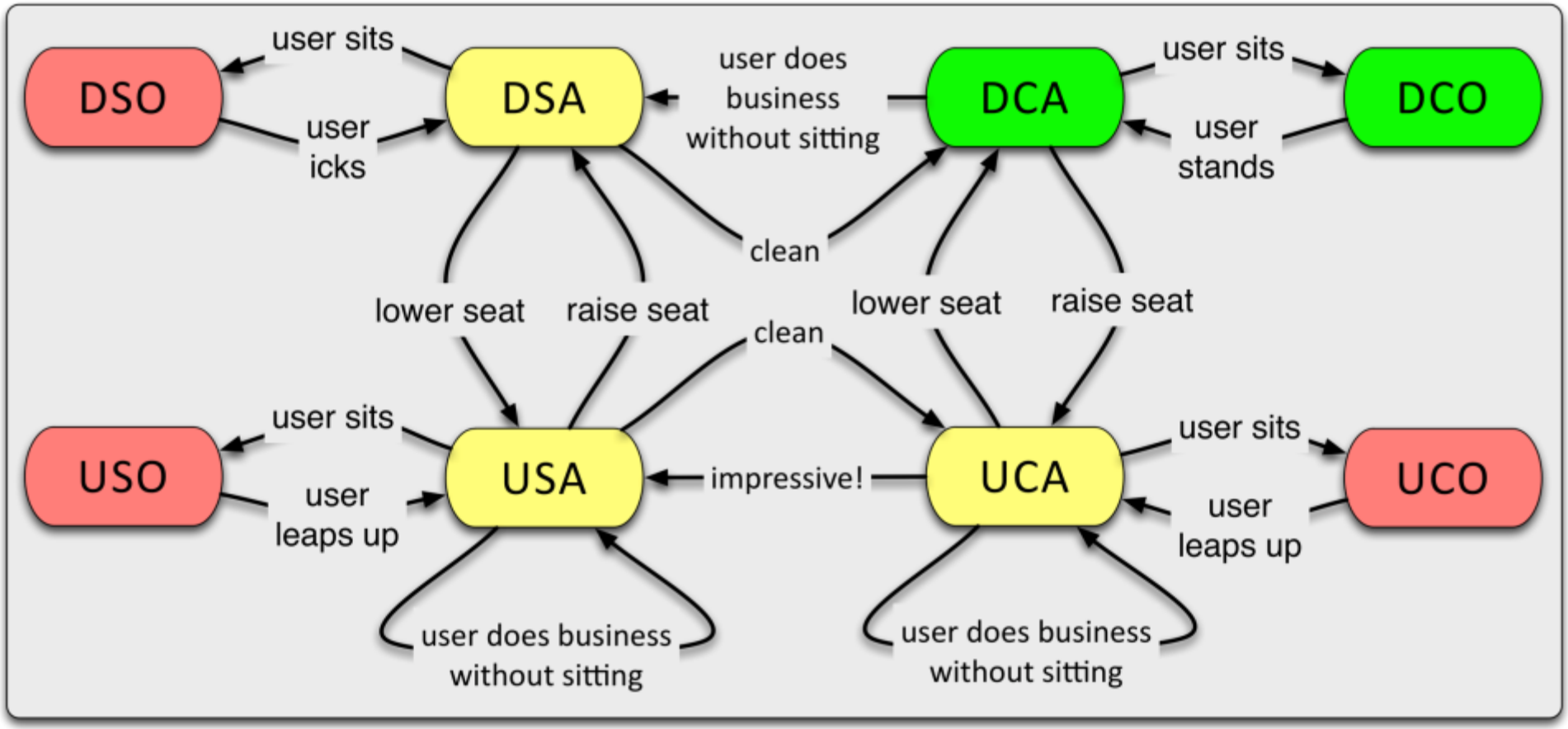

DCA


DCA
user sits
user
stands
DCO


DCA
user sits
DCO
user
stands
lower seat
raise seat
UCA

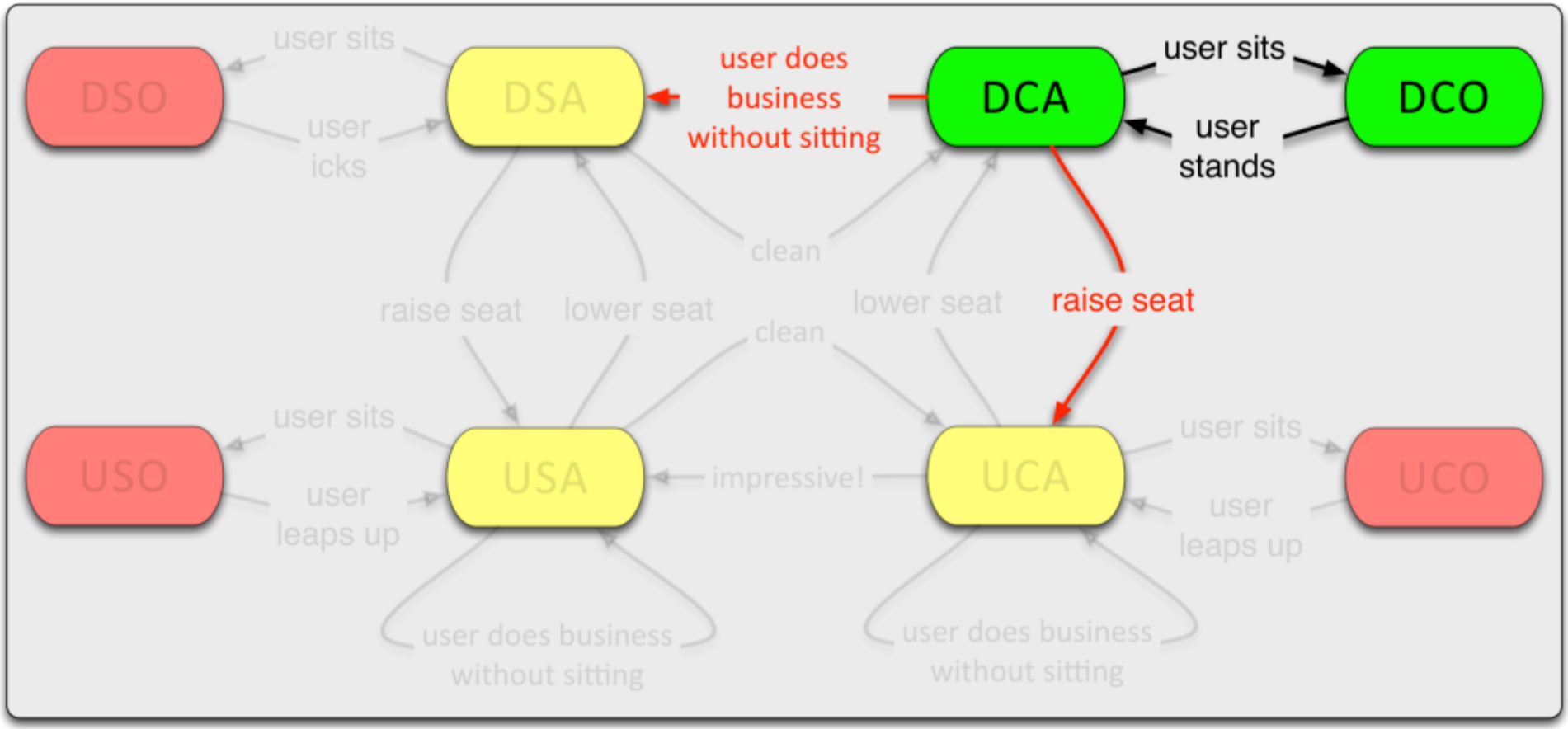

DCA
user sits
DCO
user
stands
lower seat
raise seat
UCA
user does business
without sitting


DCA
user sits
DCO
user
stands
lower seat
raise seat
UCA
user sits
UCO
user
leaps up
user does business
without sitting


DSO
user sits
user
icks
DSA
user does
business
without sitting
DCA
user sits
user
stands
DCO
clean
lower seat
raise seat
lower seat
raise seat
clean
USO
user sits
user
leaps up
USA
impressive!
UCA
user sits
user
leaps up
UCO
user does business
without sitting
user does business
without sitting

Possible Mitigation - Hardwire

- Policy
  - Users will sit.
- Procedure
  - Sit.
- Controls
  - Bolt seat down
  - Lower ceiling


DSO
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business
without sitting
DCA
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user
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DCO
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raise seat
lower seat
lower seat
raise seat
clean
USO
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leaps up
USA
impressive!
UCA
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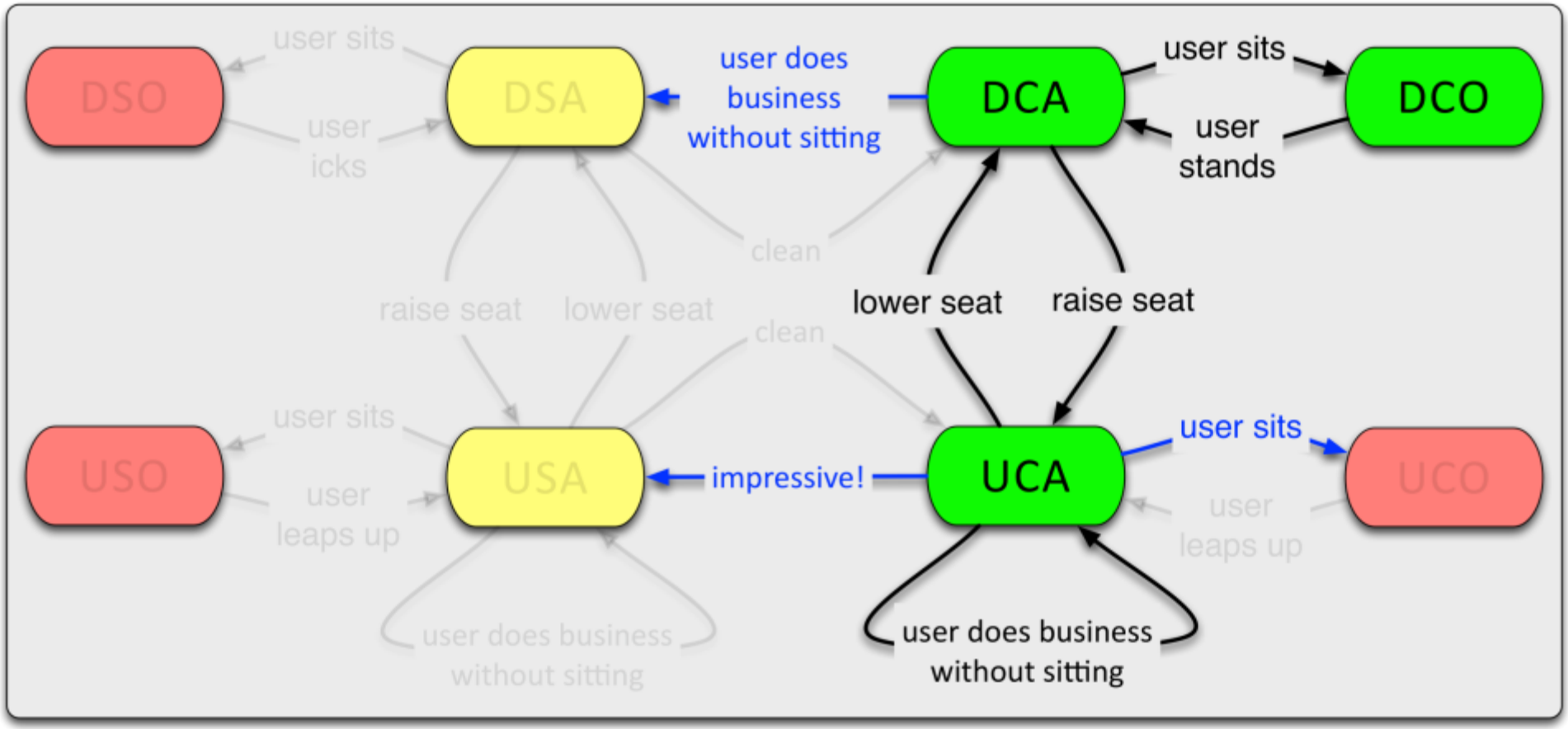
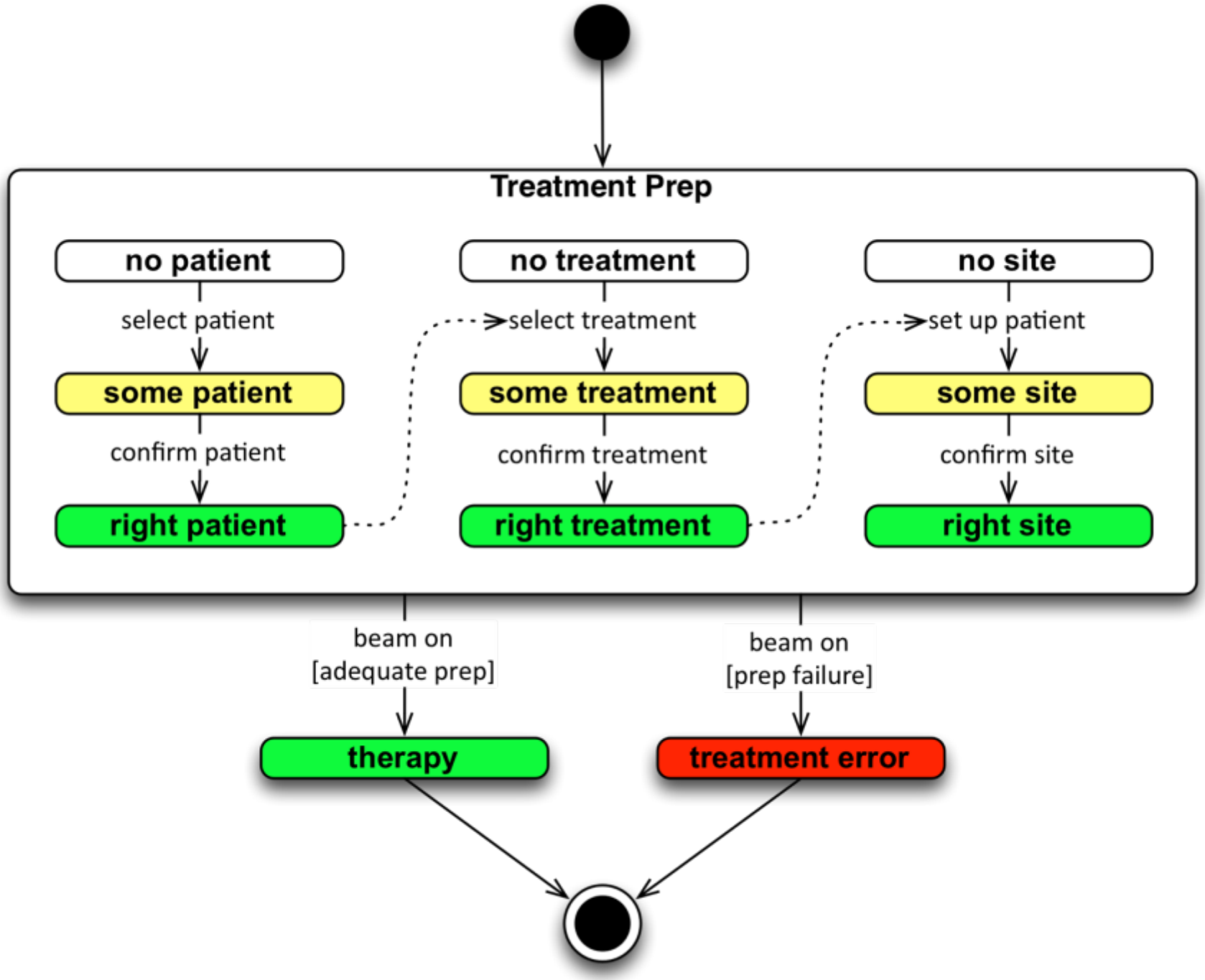
user
leaps up
UCO
user does business
without sitting
user does business
without sitting

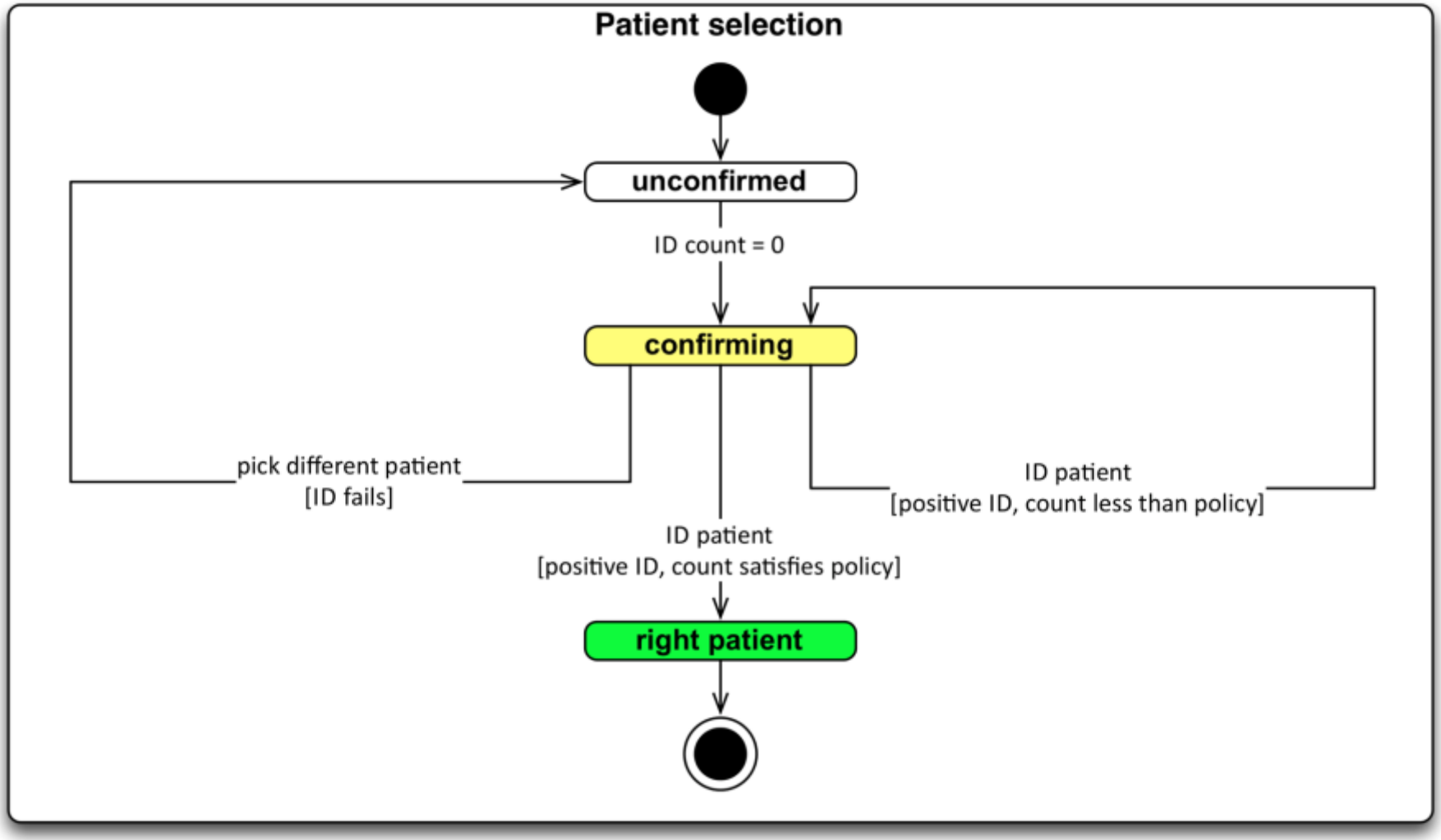
Possible Mitigation – Fair use

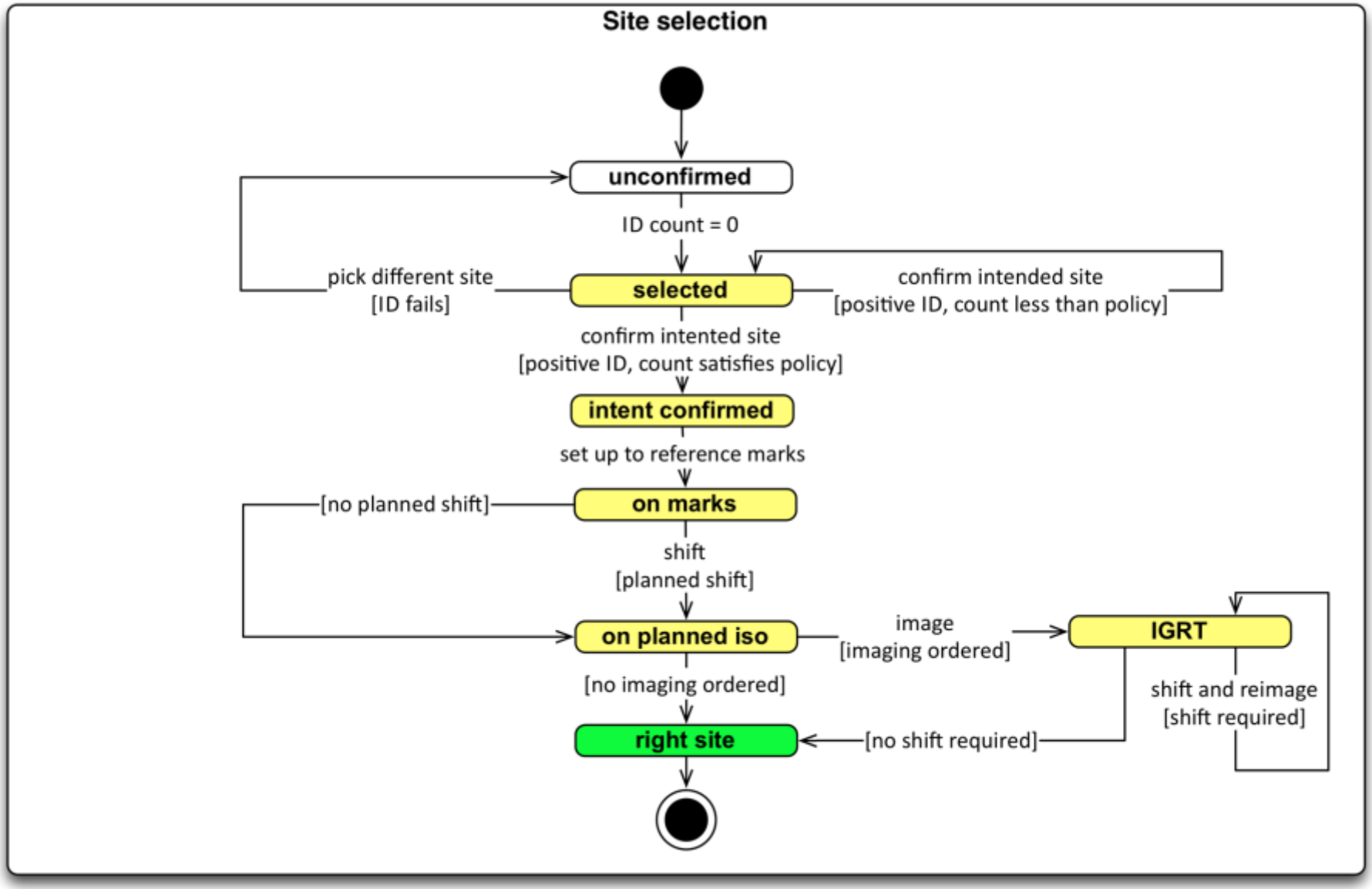
- Policy
  - The seat shall always be left clean after use.
  - Each user shall assure seat position is appropriate prior to intended use.
- Procedure
  - Assure appropriate seat position for your intended use.
  - Do your business.


DSO
user sits
user
icks
DSA
user does
business
without sitting
DCA
user sits
user
stands
DCO
clean
raise seat
lower seat
lower seat
raise seat
clean
USO
user sits
user
leaps up
USA
impressive!
UCA
user sits
UCO
user
leaps up
user does business
without sitting
user does business
without sitting

RADIATION THERAPY


Treatment Prep
no patient
select patient
some patient
confirm patient
right patient
no treatment
select treatment
some treatment
confirm treatment
right treatment
no site
set up patient
some site
confirm site
right site
beam on
[adequate prep]
therapy
beam on
[prep failure]
treatment error


Patient selection
unconfirmed
ID count = 0
confirming
pick different patient
[ID fails]
ID patient
[positive ID, count less than policy]
ID patient
[positive ID, count satisfies policy]
right patient


Site selection
unconfirmed
ID count = 0
selected
pick different site
[ID fails]
confirm intended site
[positive ID, count less than policy]
confirm intented site
[positive ID, count satisfies policy]
intent confirmed
set up to reference marks
on marks
[no planned shift]
shift
[planned shift]
on planned iso
image
[imaging ordered]
IGRT
shift and reimage
[shift required]
[no imaging ordered]
right site
[no shift required]

In practice…

- There is sometimes not a clear indication that a clinical process is in a hazardous state.
- That analysis needs to be performed independently, and hopefully in advance.
- Hazard mitigation involves using available controls to prevent or protect certain state transitions.
- This can be awkward with current IS systems.

Treatment stops in MOSAIQ

- No treat without field approval
- No treat without prescription approval
- No treat without “treatment plan” document approval by 1 to 3 user types.
- Which, how many, when, where?
- P&P implications
- Workflow implications

In summary…

State diagramming as used in control systems engineering offers a useful complement to other hazard analysis tools like process mapping, FMEA, FTA.