MOBILE AMBIENTS

- Locations represented by a topology of boundaries.

  Not identified with globally unique names.

- Process mobility represented as crossing of boundaries.

  Not as communication of processes or process names over channels.

- Security represented as ability / inability to cross boundaries.
- Interaction between processes is by shared location within a common boundary.

Mobile Ambients

n names

$P, Q ::=$ processes

$(\nu n)P$

0

$P \mid Q$

$!P$

$n[P]$ ambient

$M.P$ action

$M ::=$ capabilities

$\mathsf{in}\ n$

$\mathsf{out}\ n$

$\mathsf{open}\ n$

Subjective Moves

$$n[\mathsf{in}\ m.P \mid Q] \mid m[R] \to m[n[P \mid Q] \mid R]$$

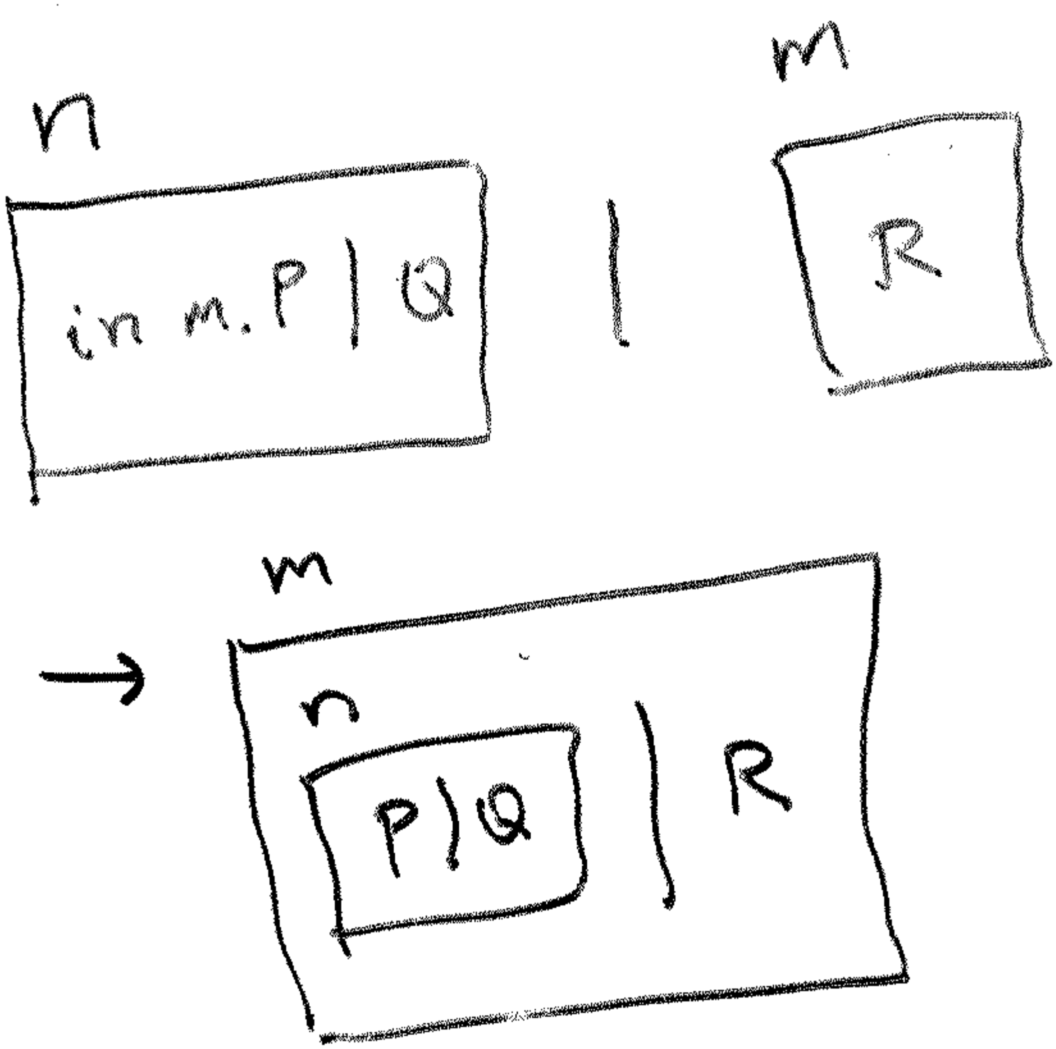
$$m[n[\mathsf{out}\ m.P \mid Q] \mid R] \to m[R] \mid n[P \mid Q]$$

$$\mathsf{open}\ m.P \mid m[Q] \to P \mid Q$$

ENTRY CAPABILITY

$$n[\underline{in\ m.P} \mid Q] \mid m[R]$$

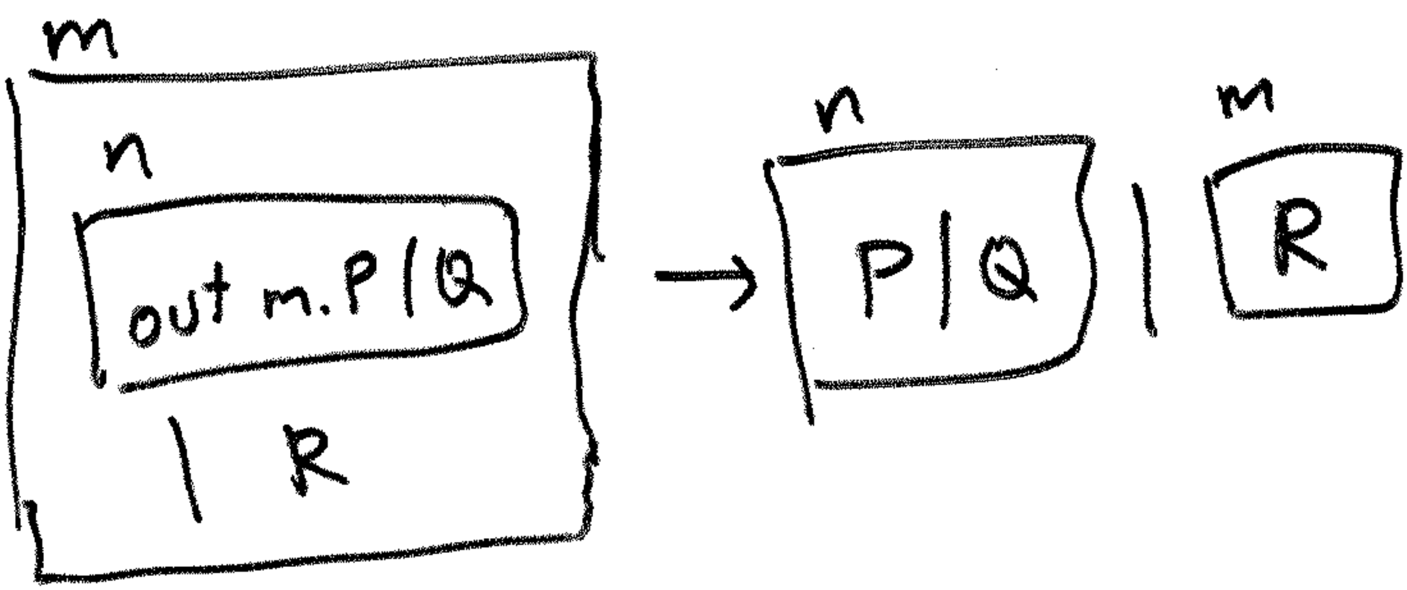
$$\longrightarrow m[n[P \mid Q] \mid R]$$



EXIT CAPABILITY

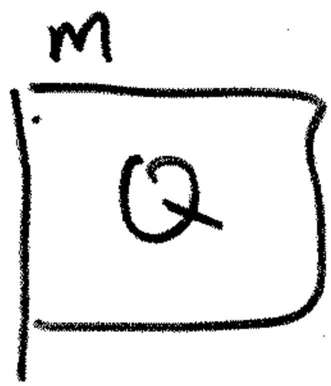
$$m[n[\underline{\text{out } m}.P \mid Q] \mid R] \longrightarrow$$

$$n[P \mid Q] \mid m[R]$$



OPEN CAPABILITY

$$\text{open } m.P \mid m[Q]$$
$$\rightarrow P \mid Q$$

$\text{open } m.P \mid$ 

$$\longrightarrow P \mid Q$$

OBJECTIVE MOVES

$$mv\ in\ m.P \mid m[R] \rightarrow m[P \mid R]$$

$$m[mv\ out\ m.P \mid R] \rightarrow P \mid m[R]$$

AMBIENT I/O

$(x).P$ input [synchronous]

$\langle x \rangle$ output [asynchronous]

$$(x).P \mid \langle M \rangle \rightarrow P\{M/x\}$$

$$P\{x \leftarrow M\}$$

ENCODING OBJECTIVE MOVES w/ SUBJECTIVE MOVES

$$\text{allow } n \triangleq \,!\text{open } n$$

$$\underline{\text{mv in } n.P} \triangleq$$

$$(\nu k)\ k[\text{in } n.\ \text{enter}[\text{out } k.\ \text{open } k.\ P]]$$

$$\underline{n^{b}[P]} \triangleq n[P \mid \text{allow enter}]$$

$$\text{mv in } n.P \mid n^{b}[Q] \xrightarrow{*} \underline{n^{b}[P \mid Q]}$$

<u>PROOF</u>:

$$\underline{(\nu k)}\big(k[\underline{\text{in } n.}\ \text{enter}[\text{out } k.\ \text{open } k.\ P]] \mid$$
$$n[Q \mid \,!\text{open}\ \cancel{\text{allow}}\ \text{enter}]\big) \longrightarrow$$

$$(\nu k)\ n[k[\text{enter}[\underline{\text{out } k.}\ \text{open } k.\ P]] \mid Q \mid$$
$$!\text{open enter}]$$

$$(\nu k)\ n[\text{enter}[\text{open } k.\ P] \mid k[\,] \mid Q \mid \underline{!\text{open enter}}]$$

$$(\nu k)\ n[\underline{\text{open } k.}\ P \mid k[\,] \mid Q \mid \,!\text{open enter}]$$

$$(\nu k)\ \ [P \mid Q] \equiv n^{b}[P \mid Q]$$

$\underline{\text{mv out } n}.P \triangleq$ {

$(\nu k)\, k[\text{out } n.\, \text{exit}[\text{out } k.\, \text{open } k.\, P]]$

$\underline{n^r[P]} \triangleq n[P] \mid \text{allow exit}$

$\cancel{\text{mv out } n.P \mid n^r[P] \rightarrow^*}$

$n^r[\text{mv out } n.P \mid Q] \rightarrow^* n^r[Q] \mid P$

Exercise: prove process P gets out of ambient n^r

$n^{er}[P] \triangleq n[P \mid \text{allow enter}] \mid \text{allow exit}$

REFERENCE CELL IN AMBIENT CALCULUS

$$\text{cell } c\ w \triangleq c^{\downarrow\uparrow}[\langle w \rangle]$$

$$\text{get } c\,(x).P \triangleq$$

$$\quad \text{mv in } c.(x).(\langle x \rangle \mid \text{mv out } c.P)$$

$$\text{set } c\,\langle w \rangle.P \triangleq$$

$$\quad \text{mv in } c.(x).(\langle w \rangle \mid \text{mv out } c.P)$$

Locks Example

$$\text{acquire } n.P \triangleq \text{open } n.P$$

$$\text{release } n.P \triangleq n[\,]\,|\,P$$

$$\text{acquire } l.P \mid \text{release } l.Q \equiv$$

$$\underline{\text{open } l}.P \mid \underline{l[\,]} \mid Q \rightarrow$$

$$P \mid \emptyset \mid Q \equiv P \mid Q$$

$$\text{phil } l\ r \triangleq\ !(\text{acquire } l.\ \text{acquire } r.\ (\text{release } l \mid \text{release } r))$$

$$\text{fork } f \triangleq \text{release } f$$

$$\text{2-table} \triangleq \text{phil } f1\ f2 \mid \text{phil } f2\ f1 \mid \text{fork } f1 \mid \text{fork } f2$$

$$\text{2-table-nd} \triangleq \text{phil } f1\ f2 \mid \text{phil } f1\ f2 \mid \text{fork } f1 \mid \text{fork } f2$$

$$\text{3-table} \triangleq \text{phil } f1\ f2 \mid \text{phil } f2\ f3 \mid \text{phil } f3\ f1 \mid \text{fork } f1 \mid \text{fork } f2 \mid \text{fork } f3$$