Queueing Models of Case Managers – Work in Progress –

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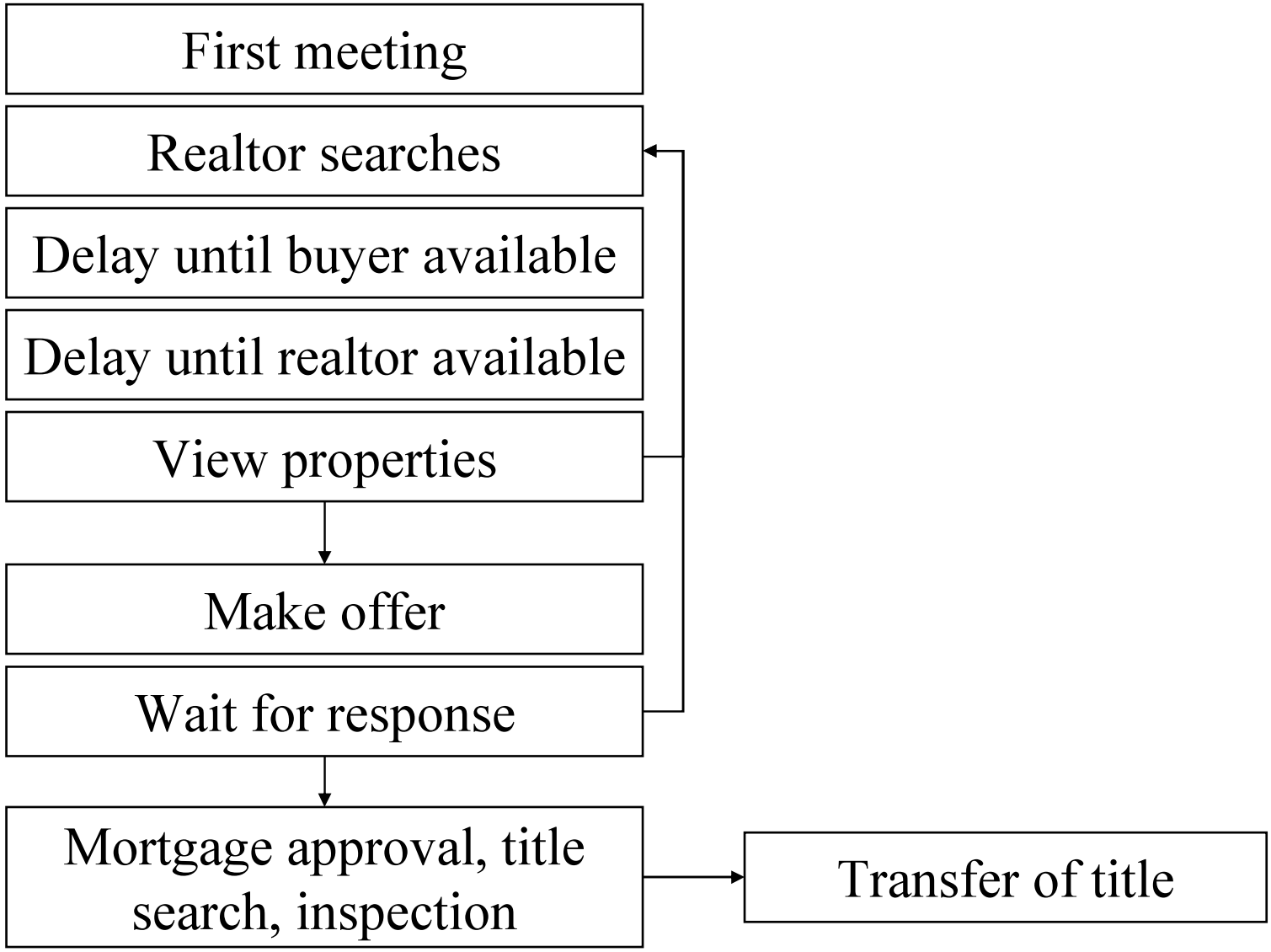
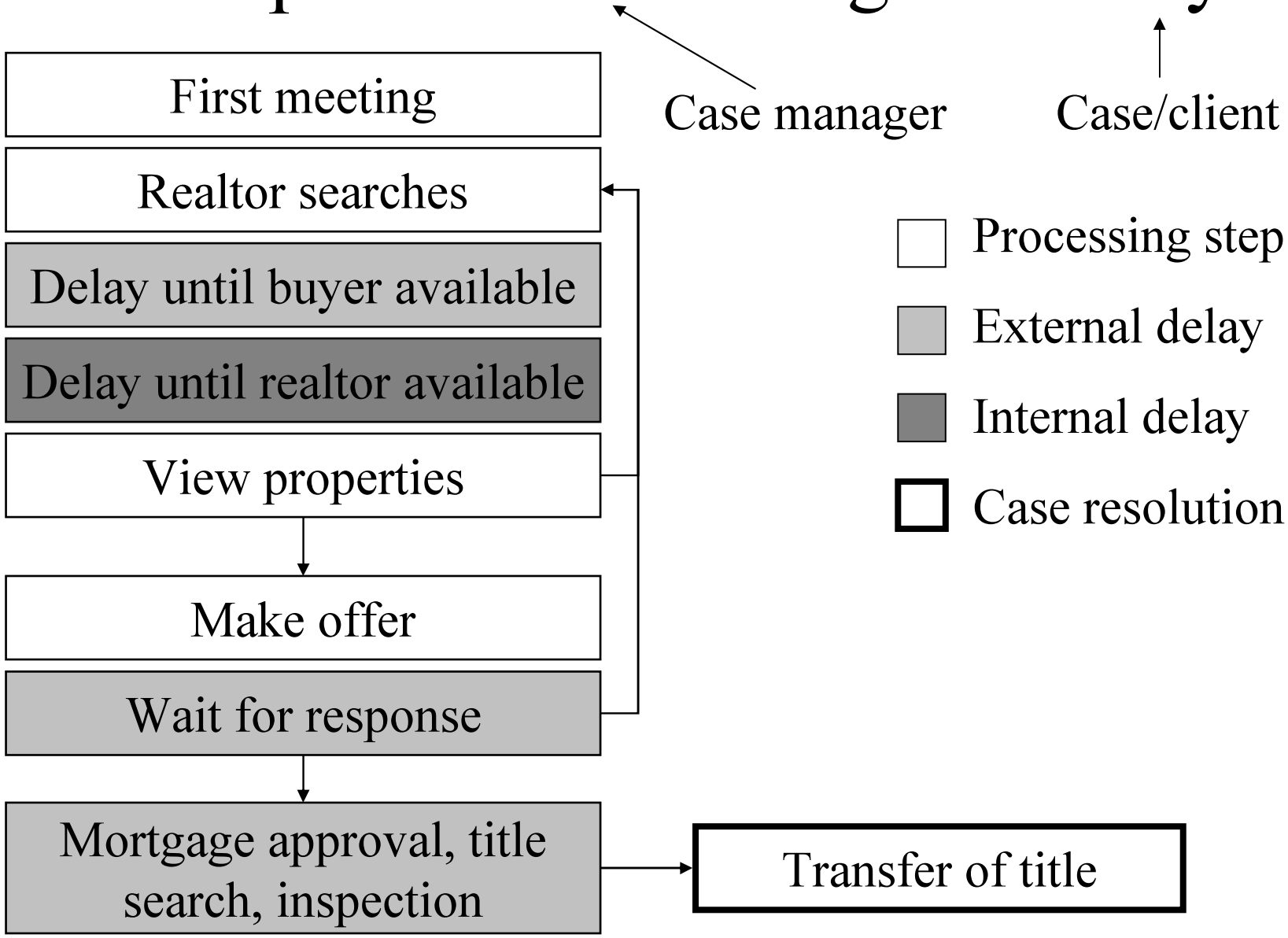
Example: Realtor acting for a Buyer



Example: Realtor acting for a Buyer



Case Management Characteristics

- Random number of processing steps
- Cases cycle through:
  - Processing step
  - External delay – beyond case manager's control
  - Internal delay – case manager attending to other cases
- … until resolution

Traditional Case Management Organizations

- Law firms
- Social services
- Health care
- Crime investigation

Case Management Emerging

- Order processing
- Insurance claims handling
- Service via Internet chat
- CRM?

Reasons for Using Case Management

- Highly customized service / product
- Frequent queries from customers
- Avoid delays / errors due to *handoffs*
- More interesting jobs
- More flexible scheduling
  - Minimum number of employees = 1
- Provide “one face to the customer”*
- “Bellwether of a new organizational form”*

* Davenport (93)

Why Develop Queuing Models of Case Management?

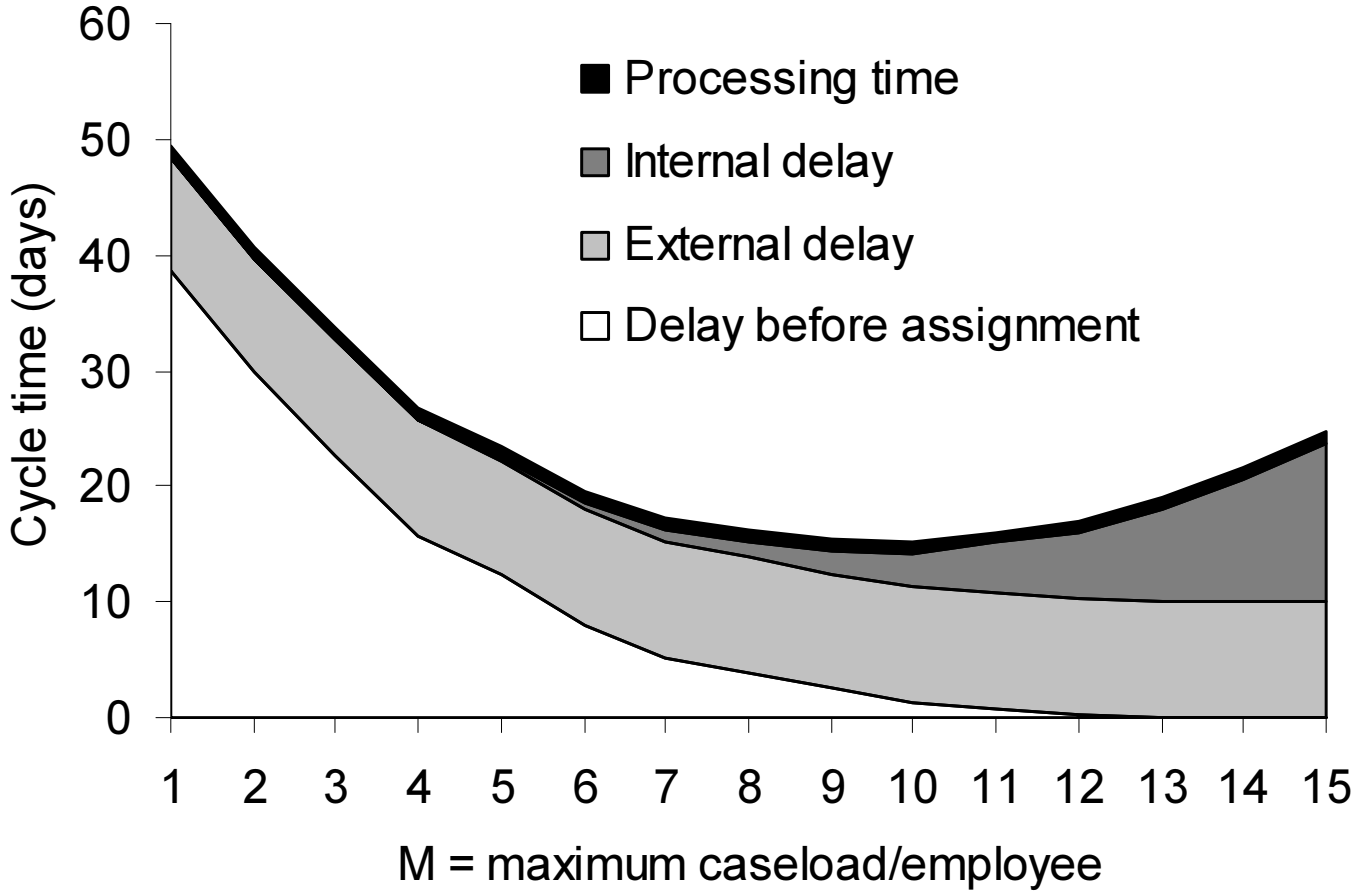
- Used in many established sectors
- Increasingly used in other sectors
- Few analytical models available to help manage case managers
  - Apte and Cavaliere (93): deterministic model
  - Gilbert (96): single case manager, fixed caseload
  - Apte, Beath and Goh (99): fixed number of processing steps per case, no external delays

Possible Performance Measures

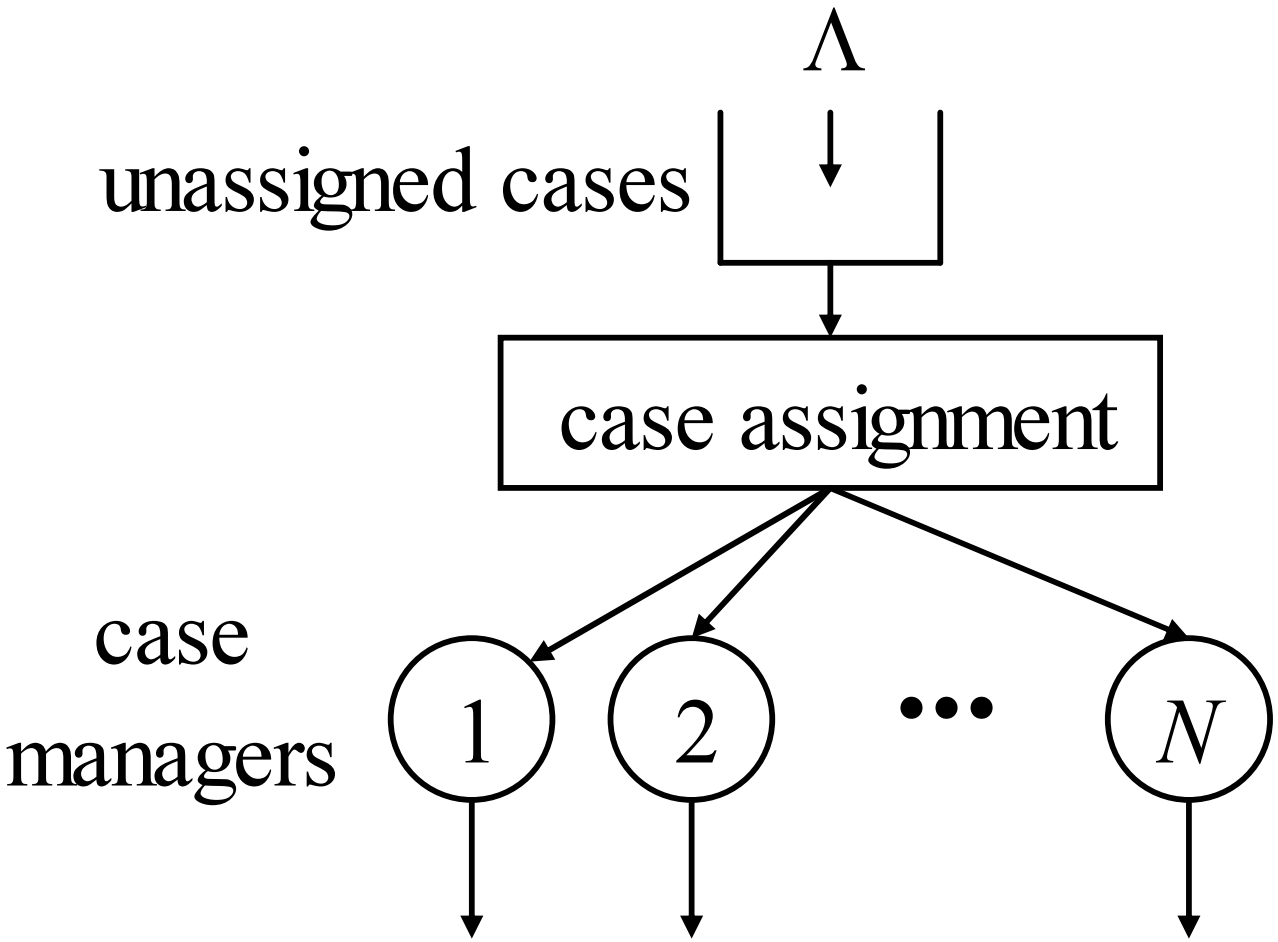
- Cases:
  - + Avg. delay b/f assignment
  - + Avg. external delay
  - + Avg. internal delay
  - + Avg. proc. time
  - = Avg. cycle time
- Case managers:
  - – Utilization
  - – Avg. caseload

What One Might Want to Know

(fictional numbers)



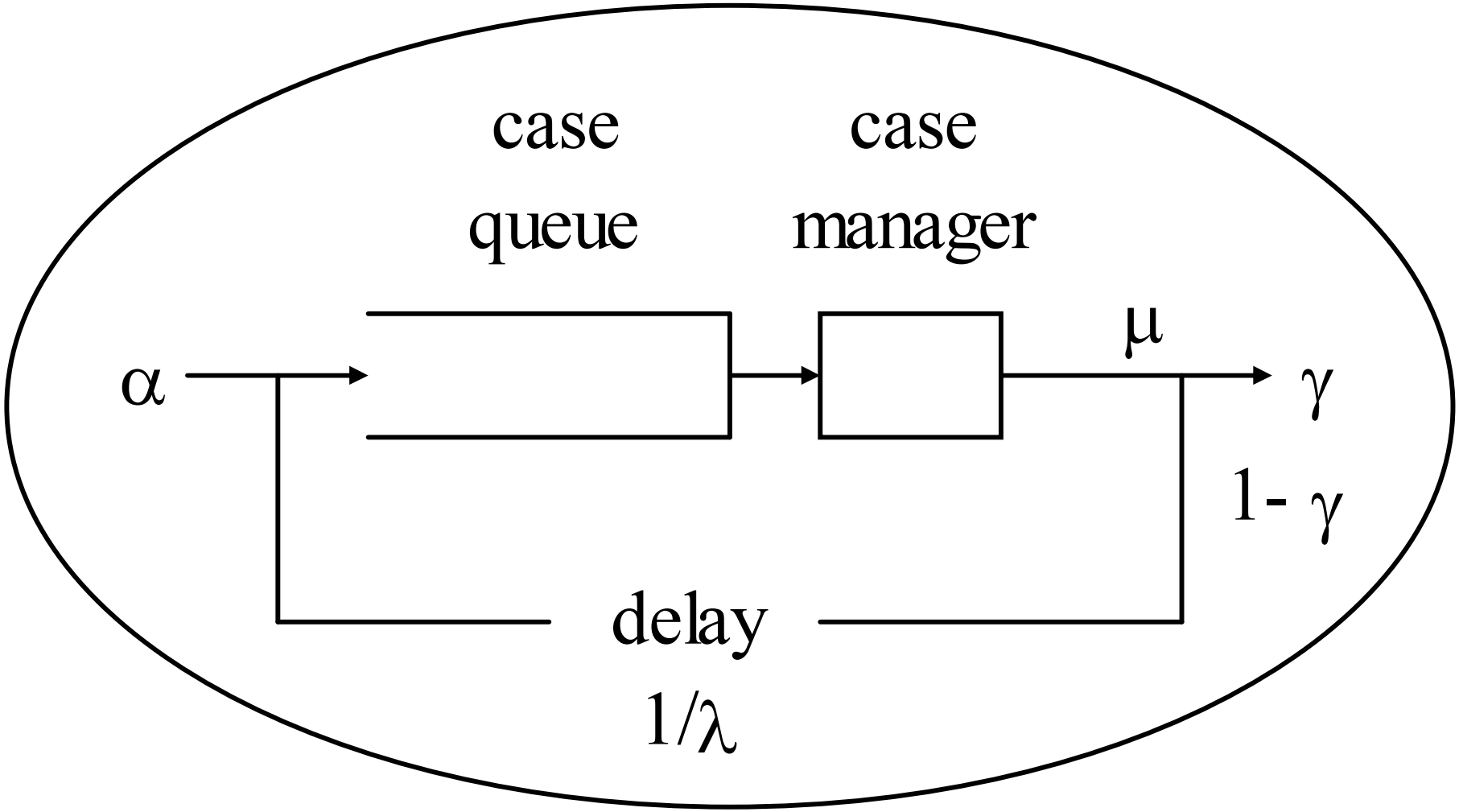
Conceptual Model: Organization of Case Managers



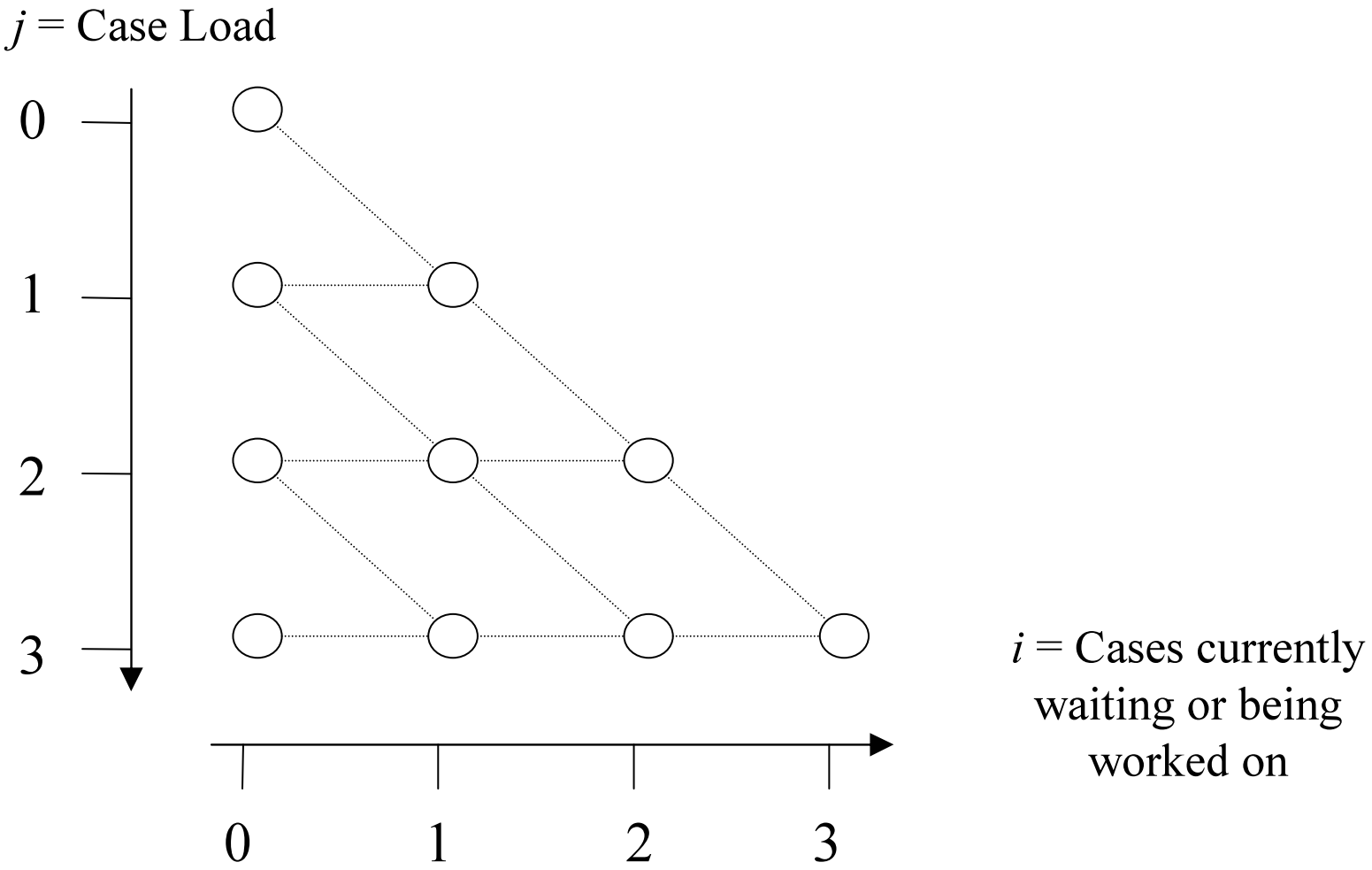
Case Assignment: A Possible Mechanism

- M = Maximum caseload
- If caseload = M for all employees, then unassigned cases wait
- If caseload < M for one or more employees, then assign case to an employee with minimal caseload
  - Break ties randomly
- Similar to "join shortest queue"

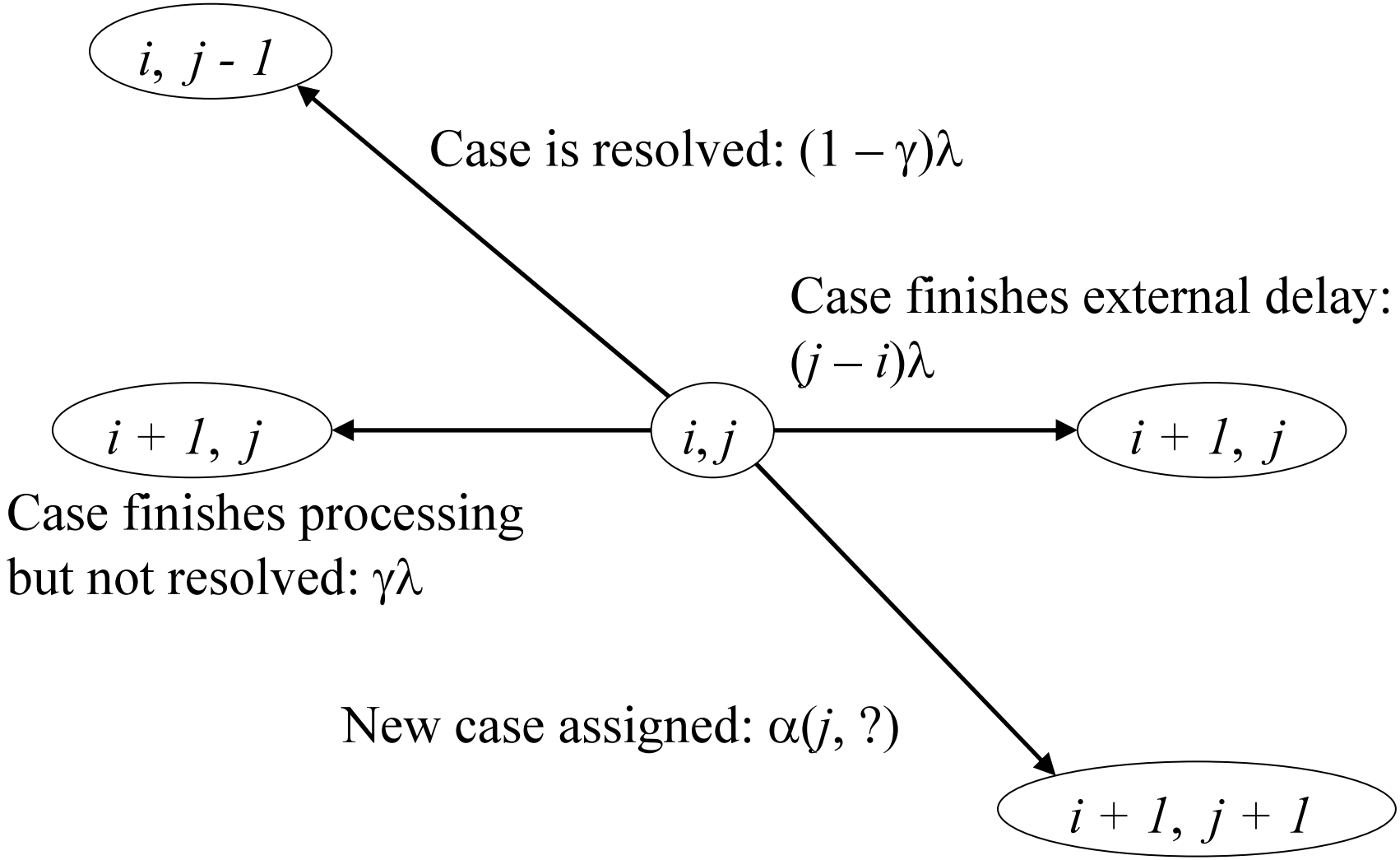
Conceptual Model: Individual Case Manager



Markov Model: Individual Case Manager



Transitions (for $0 < i < j < M$)



Decomposition by Caseload

$$\pi_{ij} = \underbrace{\Pr\left\{\begin{matrix} i \text{ cases} \\ \text{in process} \end{matrix} \middle| \begin{matrix} \text{current} \\ \text{caseload} = j \end{matrix}\right\}}_{\theta_{ij}} \underbrace{\Pr\{\text{current caseload} = j\}}_{\phi_j}$$

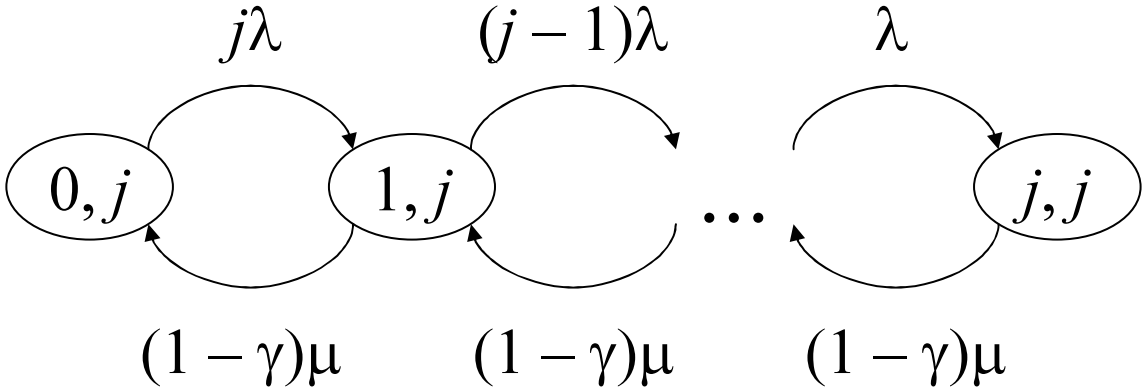
Flow balance: $\alpha_{j-1}\phi_{j-1} = \gamma\mu\phi_j\left(1-\theta_{0,j}\right)$

$$\Rightarrow \phi_j = \frac{\alpha_{j-1}}{\gamma\mu\left(1-\theta_{0,j}\right)}\phi_{j-1}, \quad j = 1, 2, \ldots, M$$

If $\theta_{0,j} \approx 0$ for $j > 0$,

then $\{\phi_j\}$ can be determined independent of $\theta_{i,j}$

Fixed Caseload: Single-Server Finite Source Queue



$$\theta_{i,j} = \frac{(j-i)\lambda}{(1-\gamma)\mu}\theta_{i-1,j}, \quad i = 1, 2, \ldots, j$$

Tying the Individual Case Managers Together

- $\phi_j = \Pr\{\text{Caseload} = j\}$
- α_j = Rate of new case assignment | caseload = j
- Given $\{\alpha_j\}$, we can determine $\{\phi_j\}$
- **Q:** Given $\{\phi_j\}$, can we approximate $\{\alpha_j\}$?
- If so, we could iterate

Or: Model Entire Organization as Markov Process

- State variables:
  - # of unassigned cases
  - For each case manager:
    - # of cases in process
    - caseload
- Possible transitions:
  - Arrival of new case | all employees busy
  - Arrival of new case | some employees available
  - Case is resolved (+ new case assignment, if cases waiting to be assigned)
  - Case finishes processing
  - Case finishes external delay

Or: Approximate with an Aggregate Model

- State variables:
  - # of unassigned cases
  - # of assigned cases
- Possible transitions:
  - Arrival of new case
  - Case is resolved (+ new case assignment?)

- Rate of case resolution determined by approximating:
  1. The distribution of all cases among case-workers, and
  2. Whether the case manager is busy, given a case-load.

Research Questions

- Can we develop accurate and useful approximations?
- Is there a significant trade-off between pre-assignment delays and internal delays?
- Can we determine optimal case-loads?
  - Minimize cycle time
  - Or: weigh pre-assignment delay differently from internal delay
- How must the model be adapted to fit a ‘real’ application?