CASoS Engineering Short Course

Message-Passing Model

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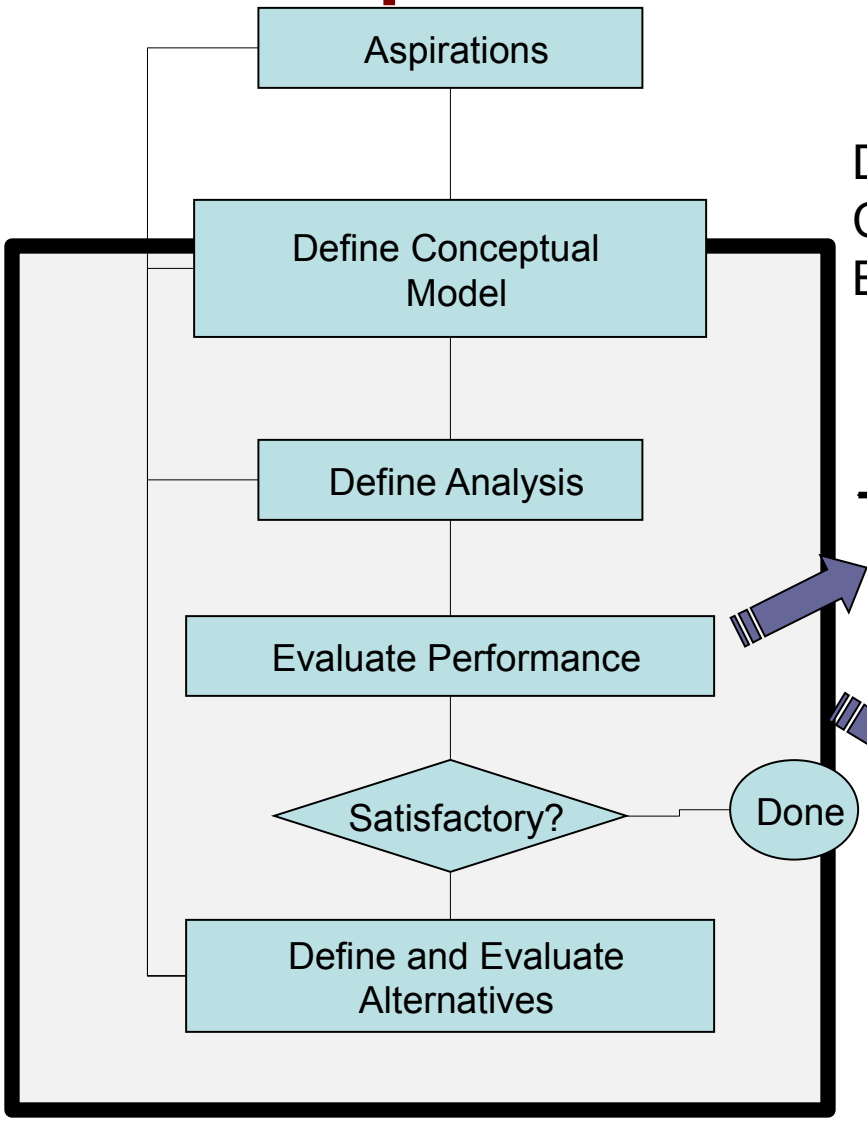
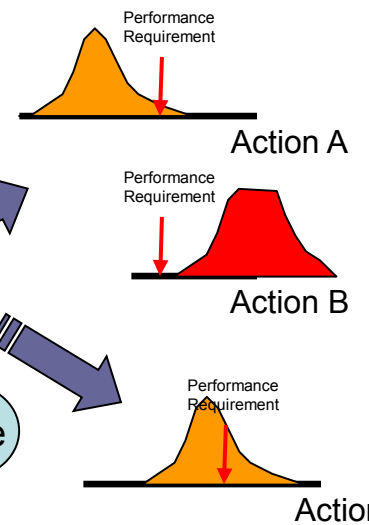
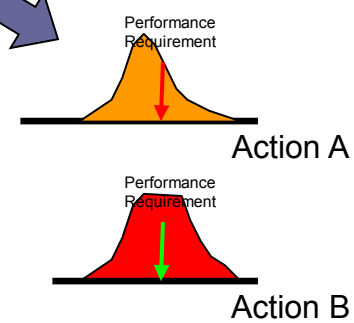
Model development: an iterative process that uses uncertainty



Decision to refine the model
Can be evaluated on the same
Basis as other actions

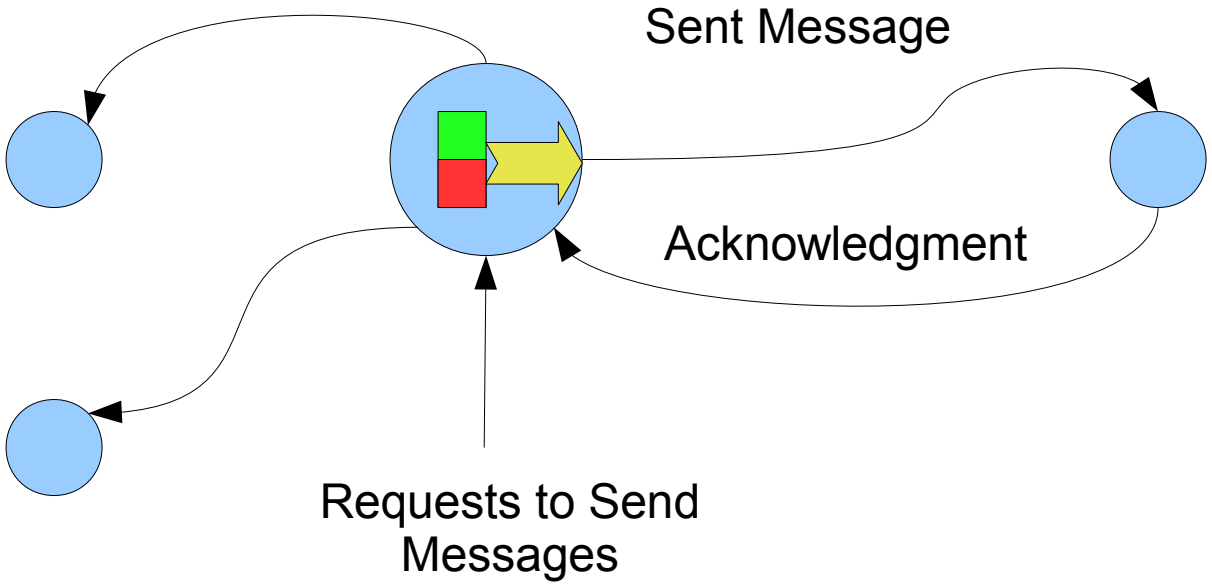


Model uncertainty permits distinctions



Model uncertainty obscures important distinctions, and reducing uncertainty has value

Demonstration Model Overview



Questions we'll be asking:

- How does a system composed of these elements behave?
- How does it respond to disruptions?
- How can we minimize disruption effects?

Model Description

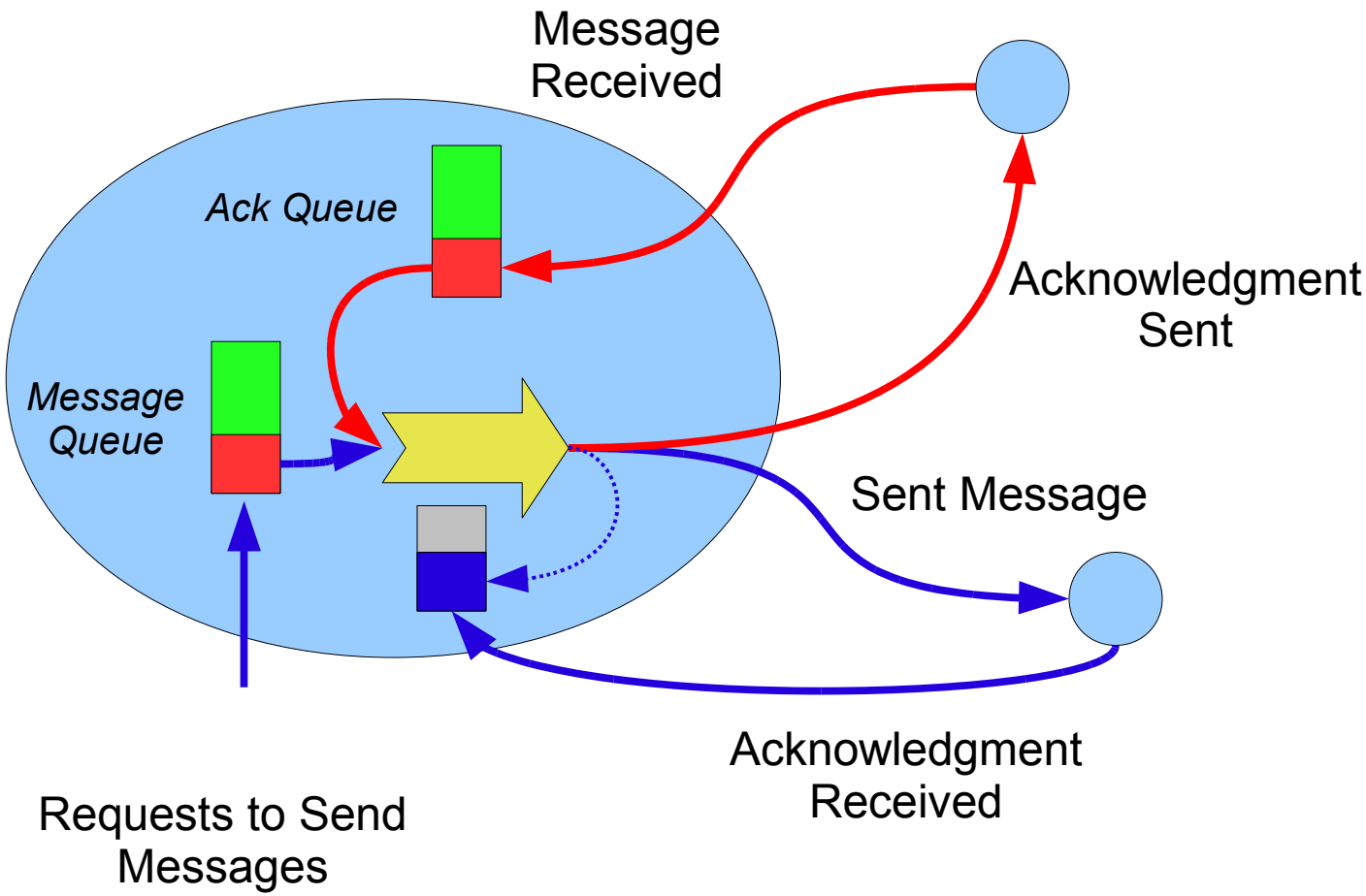
Basic processes

•The system is composed of a number of MessageHandlers which send messages to each other over connecting links
• MessageHandlers receive messages to send to network neighbors at some specified average rate. Currently this rate is constant in time and the same value for each pair of connected MessageHandlers
• Messages are placed in a queue until they can be sent
• Each message must be acknowledged by the receiving MessageHandler.
• MessageHandlers have a fixed maximum transmission rate for combined messages and acknowledgments. This maximum rate can be reduced when their queues become “large” because managing large queues consumes resources.
• Users track the delay between the arrival at the sending MessageHandler and the receipt of an acknowledgment from the receiving MessageHandler. If this delay is “long” users may increase their sending rate.

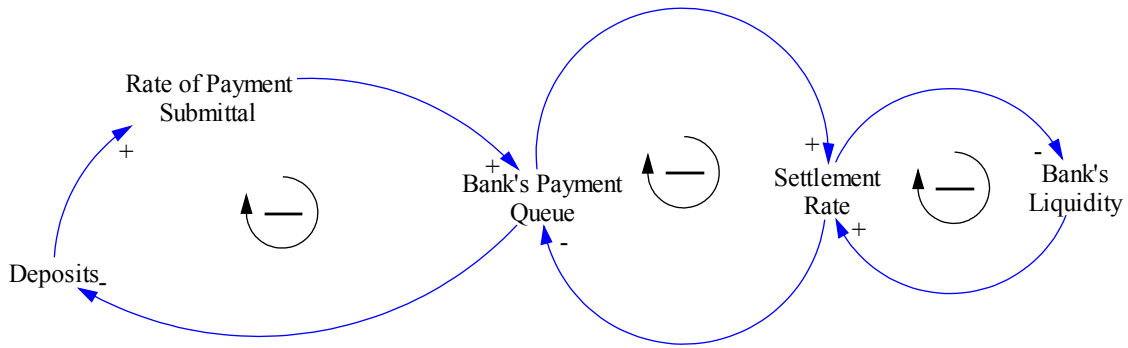
Key assumptions in the existing implementation

•The system state is updated at a sequence of uniform time steps.
• Individual messages are not distinguished as separate objects. The state of the system is completely described by the number of messages and pending acknowledgments in the various queues.

Demonstration Model Details

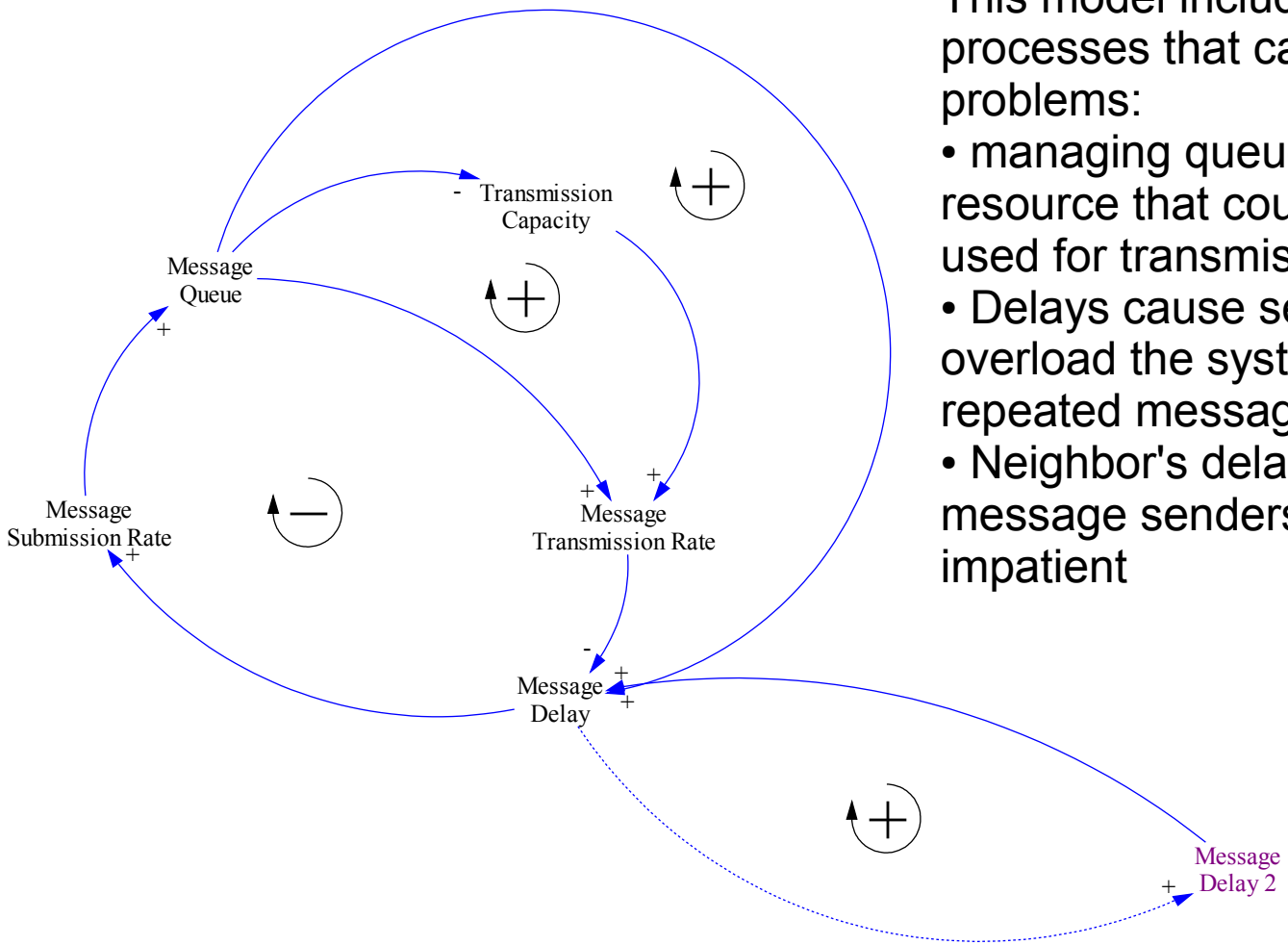


Feedback structure of the payment systems model



This is fundamentally a self-stabilizing system – there are no positive feedbacks that might amplify perturbations

Feedback structure of the message passing model



This model includes some processes that can amplify problems:

- managing queues consume resource that could have been used for transmission;
- Delays cause senders to overload the system with repeated messages
- Neighbor's delays cause my message senders to become impatient

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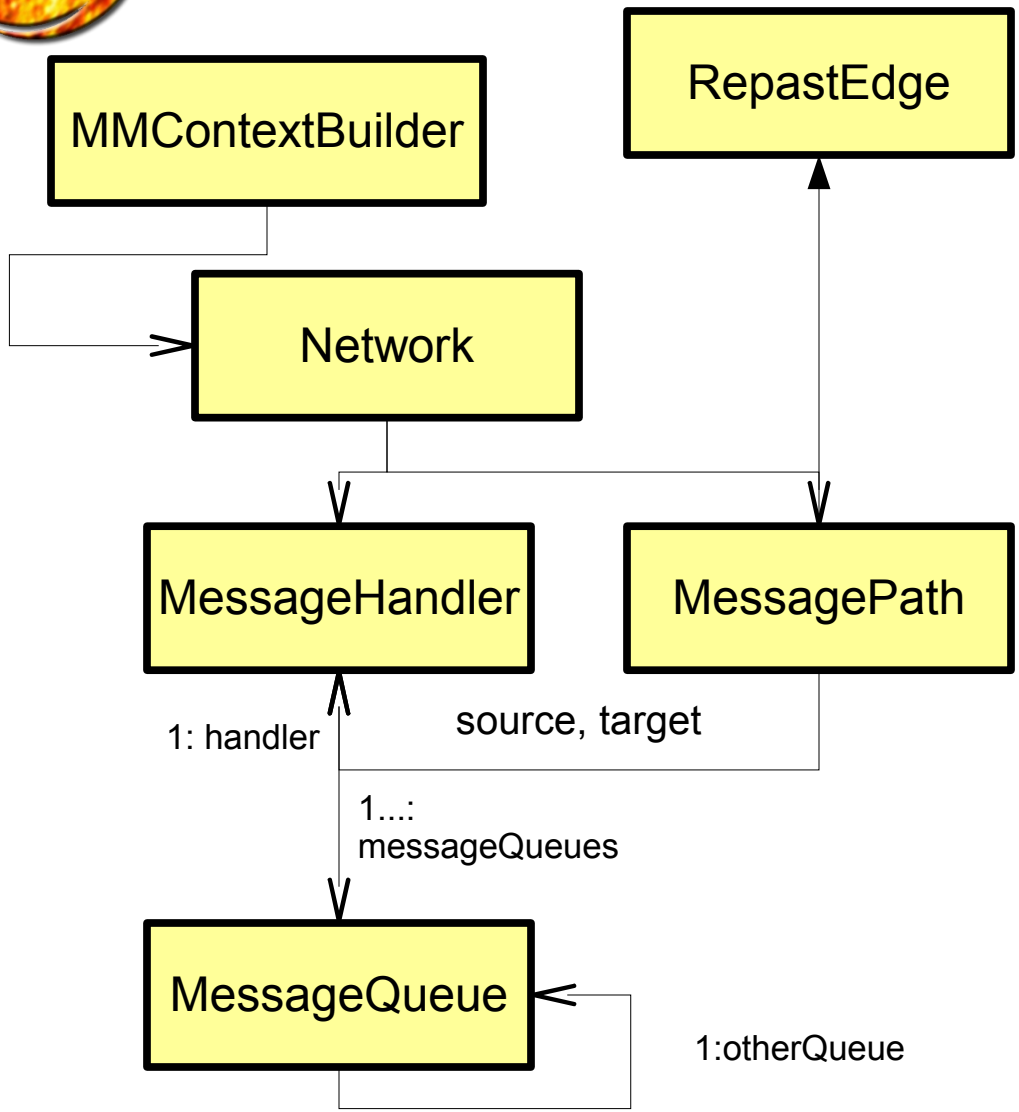
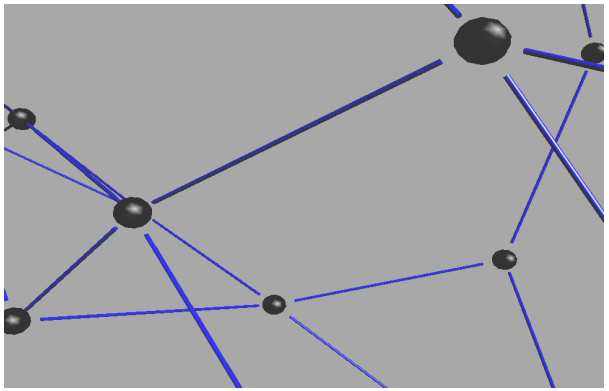
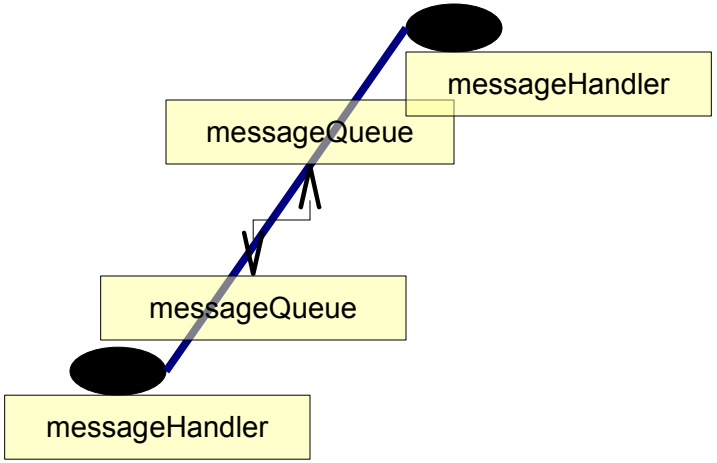
Classes







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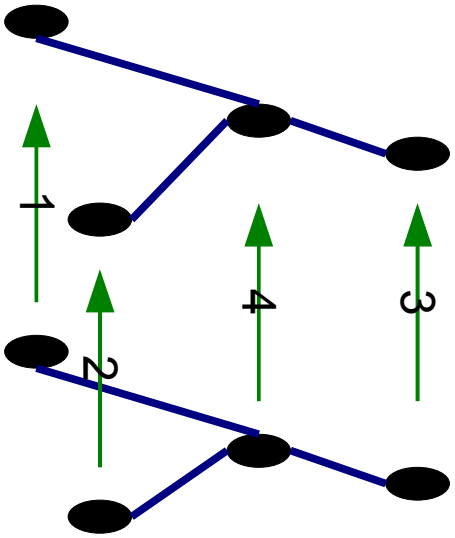
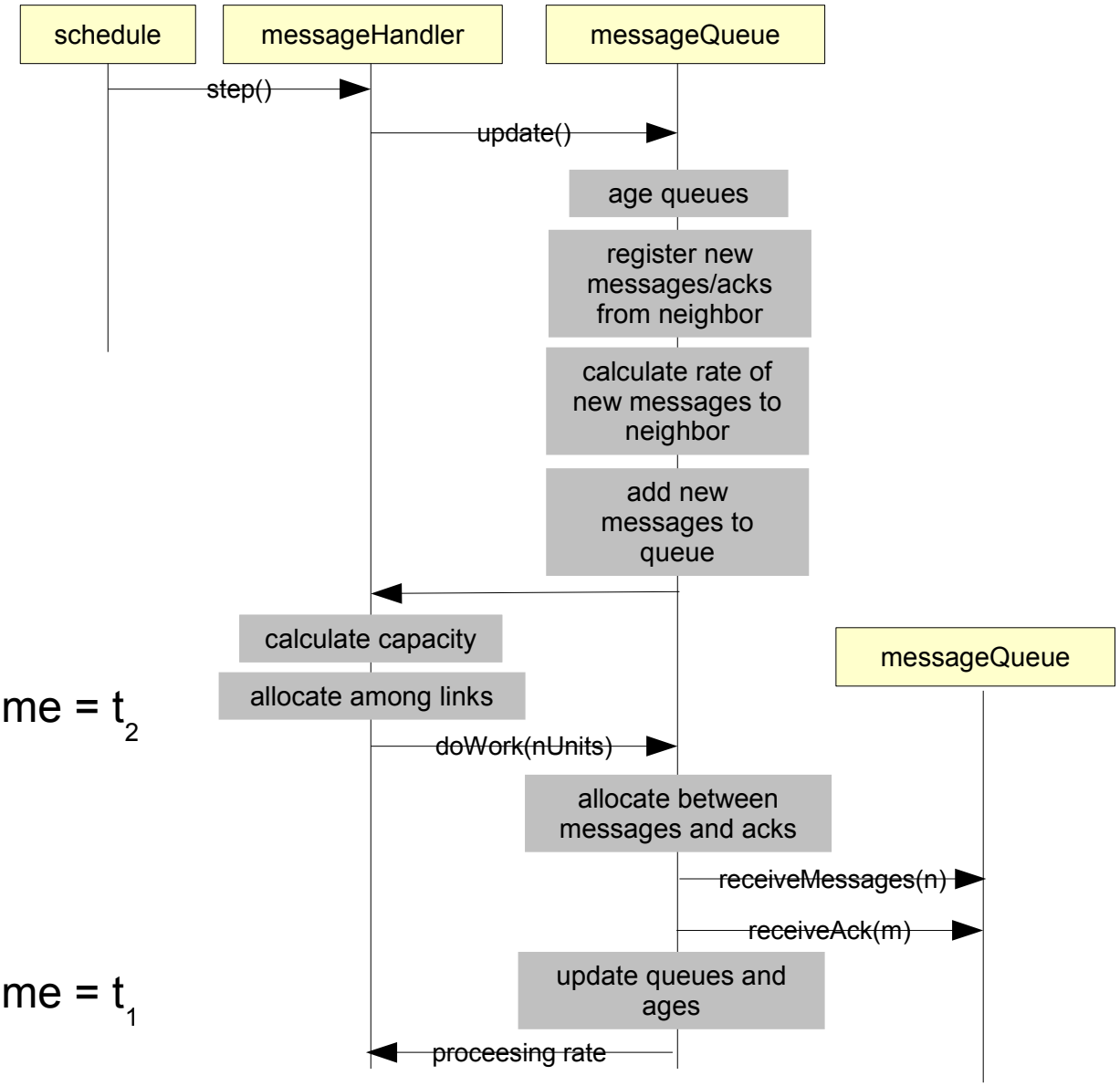
Time Stepping



time = t_2

time = t_1



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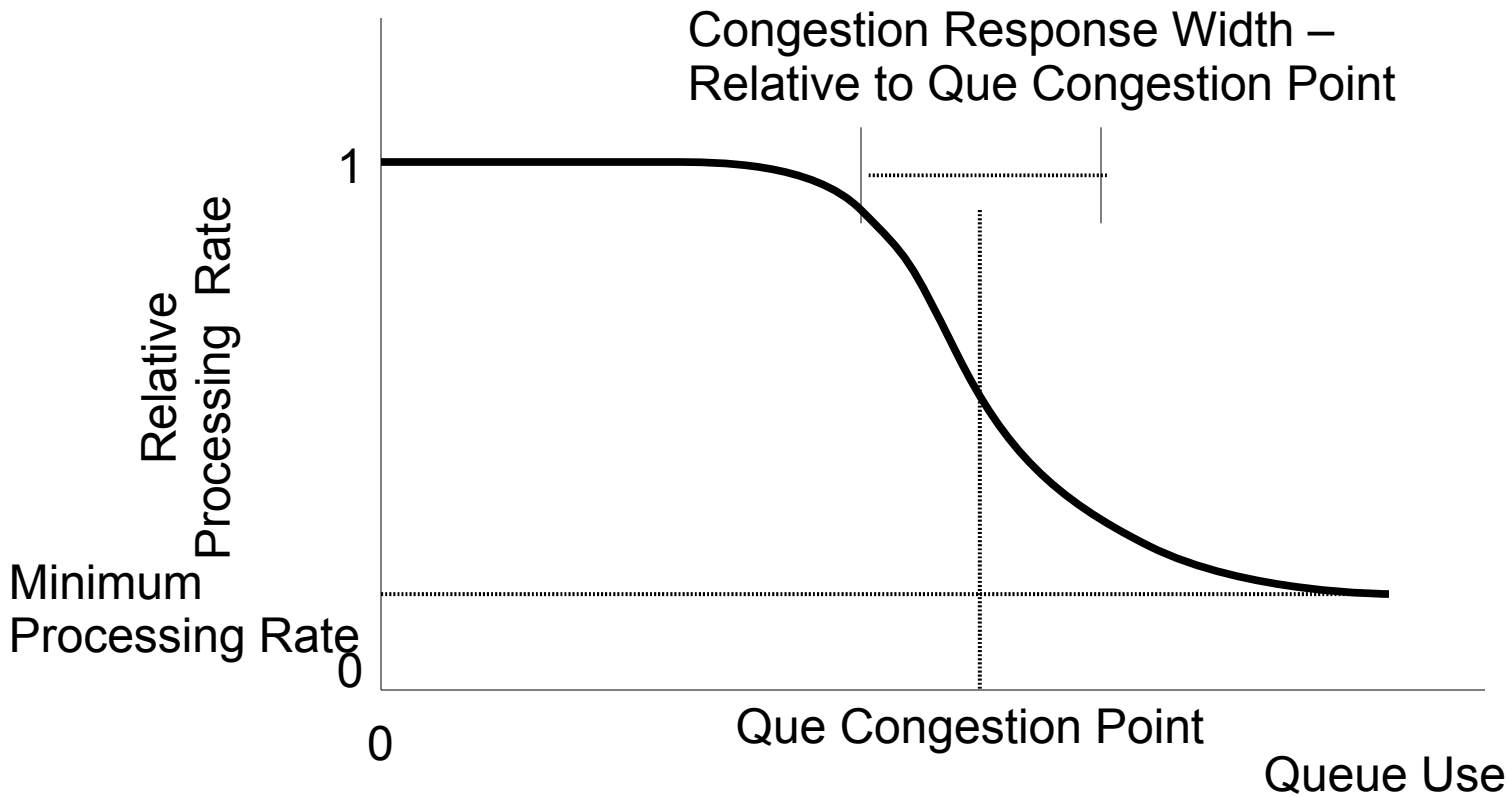
Using Sigmoid Functions to Describe Behavior



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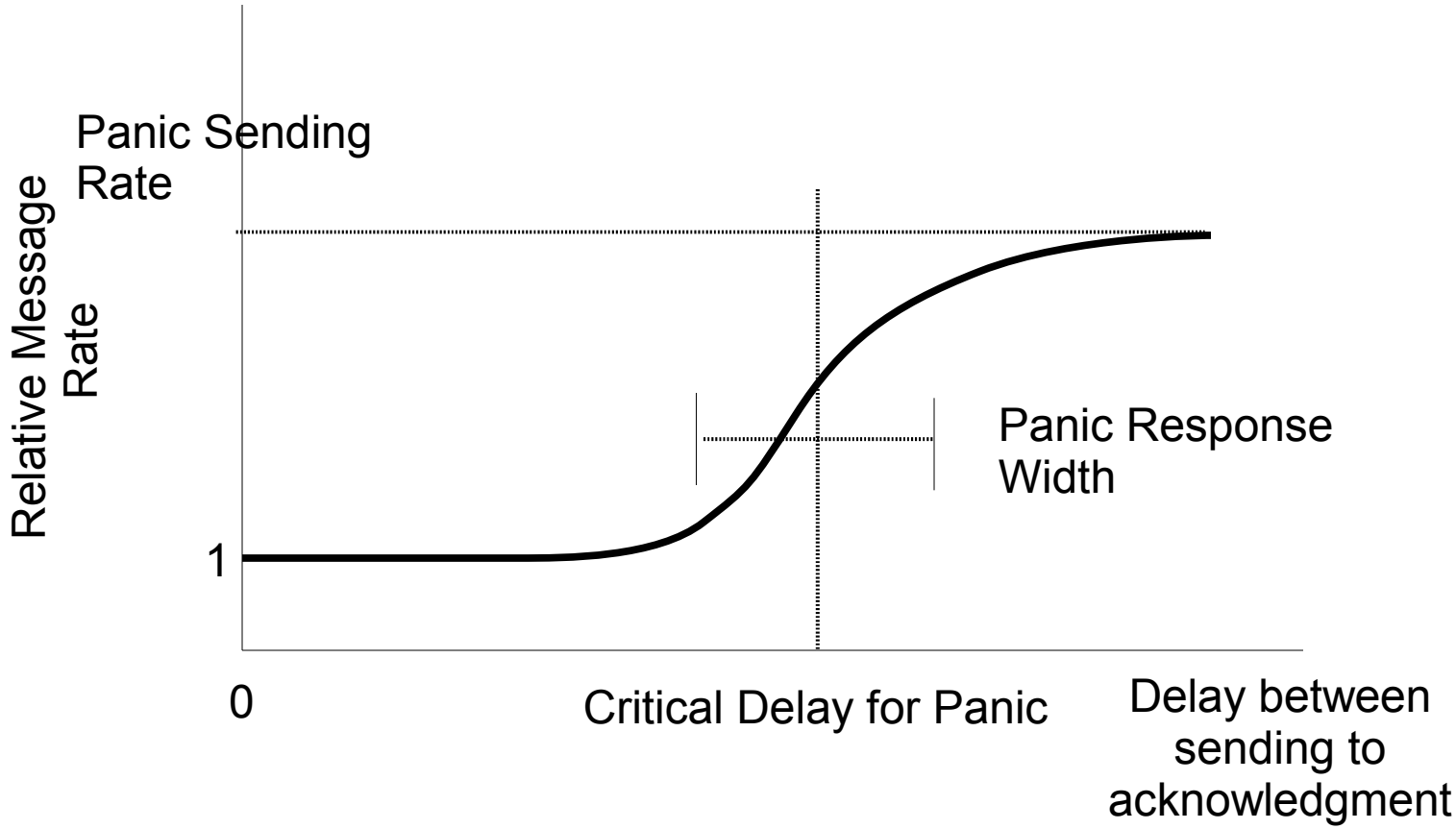

Questions to consider

On basic behavior

- What seems wrong or unusual about the behavior of the model? How would you go about explaining the behavior as either an artifact of the code or as an unexpected property of the system?
- Can this system (as modeled) undergo large-scale disruptions, or is disruption size limited to some scale? What is the scale and what determines it?
- How does network topology influence behavior? For example does it change the scale of disruptions or their duration?
- What effect does variability (for example in message rate or capacity or sender reaction functions) have on system behavior?

On implementation

- How can we build confidence in the implementation? Are there bounding results that should apply? Do they?
- Would the results be *qualitatively* different if we used discrete events instead of time steps? Why?

On use

- How effective are the policies we looked at in controlling disruptions?
- What other policies might help? How would (did) you implement them and what happened?
- What real systems might be covered by this model? What changes would be *essential* for covering a real system that interests you?