Modelling network performance with a spatial stochastic process algebra

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17 June 2010

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  - using a process algebra with stochastic, continuous and discrete aspects
- conclusions and further work

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$$P ::= P \bowtie_M P \mid P/M \mid C$$

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- instantiate functions to obtain concrete process algebra

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- let $\mathcal{P}_{\mathcal{L}} = \mathcal{L} \cup (\mathcal{L} \times \mathcal{L})$, singletons and ordered pairs

Functions for concrete process algebra

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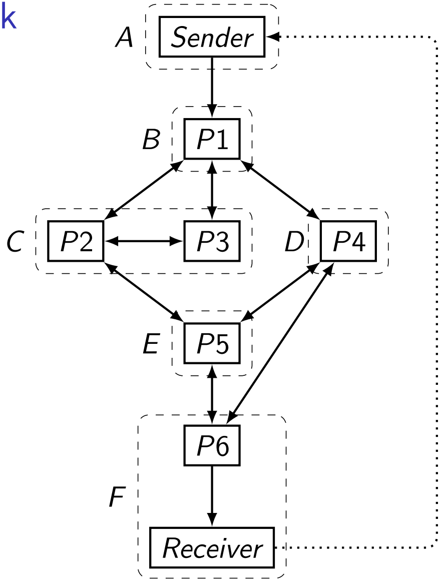
$$rsync(P_1, P_2, L_1, L_2, r_1, r_2) = \begin{cases} \dfrac{r_1}{r_\alpha(P_1)} \dfrac{r_2}{r_\alpha(P_2)} \min(r_\alpha(P_1), r_\alpha(P_2)) \cdot w((\ell_1, \ell_2)) & \\ \qquad \text{if } L_1 = \{\ell_1\}, L_2 = \{\ell_2\}, (\ell_1, \ell_2) \in E \\ \perp \qquad \text{otherwise} \end{cases}$$

Example network



PEPA model

$$Sender@A \stackrel{def}{=} (prepare, \rho).Sending@A$$
$$Sending@A \stackrel{def}{=} \sum_{i=1}^{6}(c_{Si}, r_S).(ack, r_{ack}).Sender@A$$

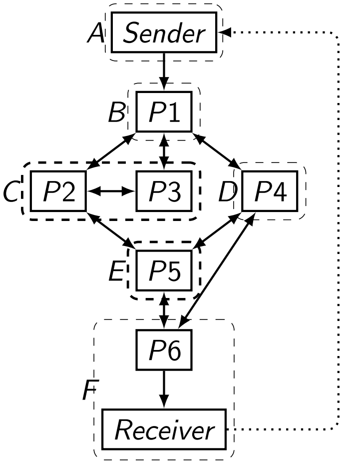
$$Receiver@F \stackrel{def}{=} \sum_{i=1}^{6}(c_{iR}, r_6).Receiving@F$$
$$Receiving@F \stackrel{def}{=} (consume, \gamma).(ack, r_{ack}).Receiver@F$$

$$P_i@\ell_i \stackrel{def}{=} (c_{Si}, \top).Q_i@\ell_i + \sum_{j=1,j\neq i}^{6}(c_{ji}, r).Q_i@\ell_i$$
$$Q_i@\ell_i \stackrel{def}{=} (c_{iR}, \top).P_i@\ell_i + \sum_{j=1,j\neq i}^{6}(c_{ij}, r).P_i@\ell_i$$

$$Network \stackrel{def}{=} (Sender@A \underset{*}{\bowtie} (P1@B \underset{*}{\bowtie} (P2@C \underset{*}{\bowtie} (P3@C \underset{*}{\bowtie} (P4@D \underset{*}{\bowtie} (P5@E \underset{*}{\bowtie} (P6@F \underset{*}{\bowtie} Receiver@F)))))))$$

Graphs

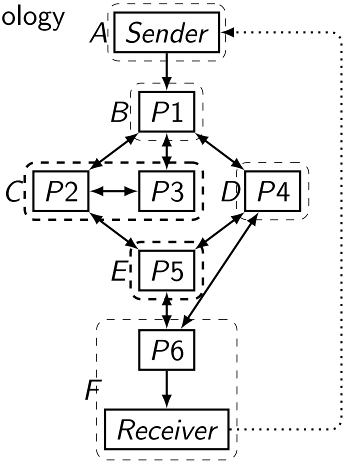
- rates: $r = r_R = r_S = 10$



Graphs

- rates: $r = r_R = r_S = 10$
- the weighted graph G describes the topology

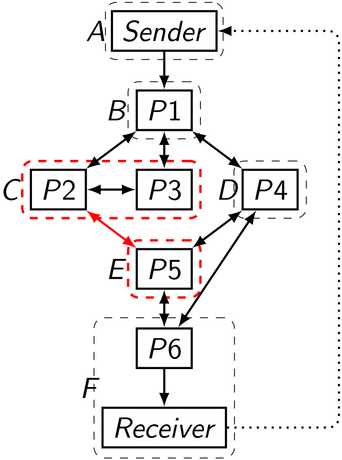
	A	B	C	D	E	F
A	1	1				
B			1	1		
C		1	1		1	
D		1			1	1
E			1	1		1
F	1			1	1	1



Graphs

- G_1 represents heavy traffic between C and E

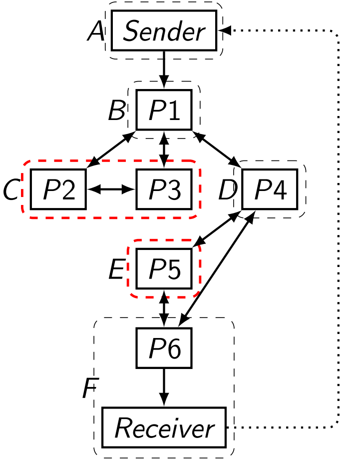
	A	B	C	D	E	F
A	1	1				
B			1	1		
C		1	1		0.1	
D		1			1	1
E			0.1	1		1
F	1			1	1	1



Graphs

- G_2 represents no connectivity between C and E

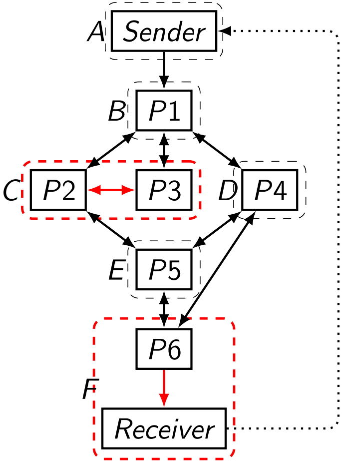
	A	B	C	D	E	F
A	1	1				
B			1	1		
C		1	1		0	
D		1			1	1
E			0	1		1
F	1			1	1	1



Graphs

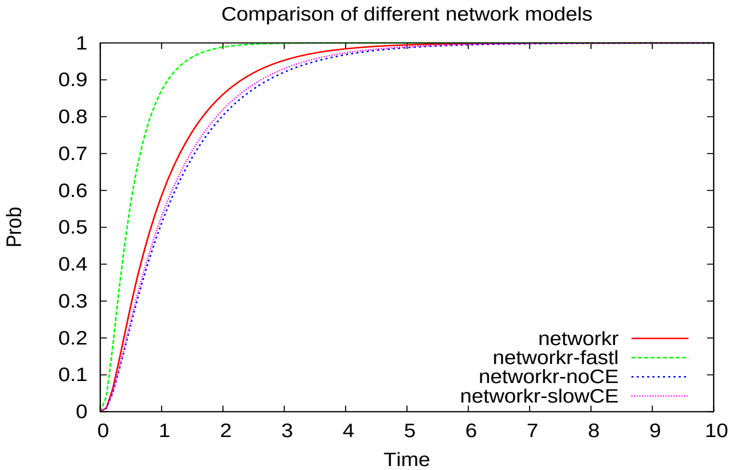
- G_3 represents high connectivity between colocated processes

	A	B	C	D	E	F
A	1	1				
B			1	1		
C		1	10		1	
D		1			1	1
E			1	1		1
F	1			1	1	10



Analysis

- cumulative density function of passage time



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  - behavioural equivalences

Thank you

This research was funded by the EPSRC SIGNAL Project

More comments

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  - biological models – BioAmbients, attributed π-calculus
- locations and collections of location
  - $\mathcal{P}_{\mathcal{L}} = 2^{\mathcal{L}}$, powerset
  - $\mathcal{P}_{\mathcal{L}} = \mathcal{L} \cup (\mathcal{L} \times \mathcal{L})$, singletons and ordered pairs
- different choices for $\mathcal{P}_{\mathcal{L}}$ give different semantics

More comments

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  - prove results for parametric process algebra

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  - prove results for parametric process algebra
  - then apply to concrete process algebra