Network Calculus Tests – Naming Scheme

Version 2.0 beta2 (2017-Jun-25)

General Information

The network calculus naming scheme presented in this document was created for the purpose of testing the Disco Deterministic Network Calculator (DiscoDNC)[1] – an open-source deterministic network calculus tool developed by the *Distributed Computer Systems (DISCO) Lab* at the University of Kaiserslautern.

Changelog:

Version 1.1 (2014-Dec-30): Match latest publications.

- Added definition of token-bucket arrival curves $\mathcal{F}_{\mathrm{TB}}$ and rate-latency $\mathcal{F}_{\mathrm{RL}}$ service curves to clear up the associated variables.
- Renamed the output bound quantifier from * to $'$.
- Renamed the newly merging cross-traffic function from x' to $\bar{x}$.
- Changed the explicit path quantifier from $s_n s_m$ to $\langle s_i, s_j \rangle$.
- Added the flow-based path quantifier $P\left(f_n\right)$.
- Added the operators used in the tests.
- Minor fixes in the examples.

Version 2.0 beta2 (2017-Jun-25):

- File Naming Scheme (newly added)
- Variable Nanimg Scheme
  - Aggregate of individual flows: changed from braces to square brackets.

[1] http://disco.cs.uni-kl.de/index.php/projects/disco-dnc

File Naming Scheme

NetworkType_Servers_ServiceCurves_Flows_ArrivalCurves_Paths(_Version)_{}

- TopologyType:
  - S – (Single) Server
  - TA – Tandem of Servers
  - TR – (Sink) Tree
  - FF – Feed-Forward
- Servers: nS, $n \in \mathbb{N}$
- ServiceCurves: mSC, $m \in \mathbb{N}$, $m \leq n$
- Flows: xF, $x \in \mathbb{N}$
- ServiceCurves: yAC, $y \in \mathbb{N}$, $y \leq x$
- Paths: zP, $z \in \mathbb{N}$, $z \leq x$, optional if TopologyType is S
- Version: ver$v$, $v \in \mathbb{N}$, optional
- TestType:
  - Network – the network topology and the flows
  - Test – the expected test results

Examples

- S_1SC_2F_2AC_Network
- S_1SC_1F_1AC_Test
- TA_2S_1SC_2F_1AC_2P_Network
- TA_3S_1SC_3F_1AC_3P_Test
- TR_7S_1SC_3F_1AC_3P_Network
- FF_3S_1SC_2F_1AC_2P_Network
- FF_4S_1SC_4F_1AC_4P_Test

Variable Naming Scheme

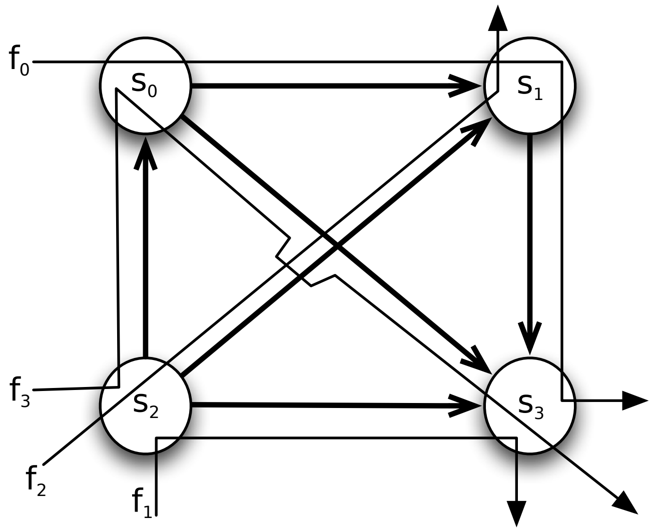
$$\text{variable}^{\text{semantic\_quantifier}}_{\text{local\_quantifier}}$$

- variables:
  - α: arrival curve
  - β: service curve
  - $\alpha_{r,b} \in \mathcal{F}_{\text{TB}}$ token-bucket arrival curves:
    $\mathcal{F}_{\text{TB}} = \{\gamma_{r,b} : \mathbb{R}^+ \to \mathbb{R}^+ \mid \gamma_{r,b}(0) = 0, \forall d > 0 : \gamma_{r,b}(d) = b + r \cdot d\}, r, b \geq 0$
  - $\beta_{R,T} \in \mathcal{F}_{\text{RL}}$ rate latency service curves:
    $\mathcal{F}_{\text{RL}} = \left\{\beta_{R,T} : \mathbb{R}^+ \to \mathbb{R}^+ \mid \beta_{R,T}(d) = R \cdot [d - T]^+\right\}, T \geq 0, R > 0$
    with $R \cdot [d - T]^+ = [R \cdot (d - T)]^+ = \max\{0, R \cdot (d - T)\}$
  - b: burst
  - T: latency
  - r, R: rate (arrival, service)
  - B: backlog bound
  - D: delay bound
- semantic quantifiers for arrival curves α and its variables (e.g., burst b):
  - f_n: arrival curve of flow f_n
  - $[f_n, \ldots, f_m]$: aggregate of arrival curves of flow $f_n, \ldots, f_m$
  - $x(f_n)$: arrival curve of all crossflows of flow f_n (needs local quantification)
  - $\bar{x}(f_n)$: arrival curve of newly joining crossflows of flow f_n (needs local quantification)
  - $'$: output bound (needs local quantification to id service curve)
  - no quantifier given: sum of all arrivals (needs local quantification)
- semantic quantifiers for service curves β and its vaiables (e.g., latency T):
  - l.o.f_n: left-over for flow f_n (needs local restriction)
    * SFA l.o.f_n: SFA left-over for flow f_n (needs local restriction)
    * PMOO l.o.f_n: PMOO left-over for flow f_n (needs local restriction)
  - no quantifier given: unaltered variable (needs local quantification)
- local quantifiers:
  - s_i: at server s_i
  - $\langle s_i, s_j \rangle$: on sub-path (see semantic quantifier) between s_i and s_j:
    * α: data arrivals on link from s_i to s_j, i.e., there must be a direct link
    * β: convolved service curve on the path from s_i to s_j (both included)
  - e2e: end-to-end (only in conjunction with β as well as it's rate R and latency T)
  - $P(f_n)$: on the path of flow f_n

Operators

- $(\min, +)$-convolution: $\otimes$
- $(\min, +)$-deconvolution: $\oslash$
- non-decreasing, non-negative subtraction: $\ominus$
- pointwise addition: $+$
- pointwise subtraction: $-$
- non-negative results: $[\cdot]^{+} = \max\{0, \cdot\}$

Examples



- $\alpha^{f_0} = \alpha^{f_0}_{s_0} = \alpha^{x(f_3)}_{s_0}$
- $\alpha^{f_2}_{s_1} = \alpha^{f_2}_{s_2 s_1} = \left(\alpha^{f_2}_{s_2}\right)' = \left(\alpha^{f_2}\right)'$
- $\alpha^{x(f_2)}_{s_1} = \alpha^{f_0}_{s_0 s_1} = \left(\alpha^{f_0}_{s_0}\right)' = \left(\alpha^{f_0}\right)'$
- $\alpha^{x(f_1)}_{s_2} = \alpha^{[f_2,f_3]} = \alpha^{f_2+f_3} = \alpha^{f_2} + \alpha^{f_3}$
- $\alpha_{s_2} = \alpha^{[f_1,f_2,f_3]} = \alpha^{f_1}_{s_2} + \alpha^{f_2}_{s_2} + \alpha^{f_3}_{s_2} = \sum_{n=1}^{3} \alpha^{f_n}_{s_2} = \sum_{n=1}^{3} \alpha^{f_n} = \alpha^{f_1+f_2}_{s_2} + \alpha^{f_3} = \alpha^{f_1+x(f_1)}$
- $\alpha_{s_2} = \alpha^{f_n} + \alpha^{x(f_n)}_{s_2}$, $n \in \{1,2,3\}$
- $\alpha_{s_3} = \alpha_{\langle s_0,s_3\rangle} + \alpha_{\langle s_1,s_3\rangle} + \alpha_{\langle s_2,s_3\rangle} = \alpha^{f_3}_{\langle s_0,s_3\rangle} + \alpha^{f_0}_{\langle s_1,s_3\rangle} + \alpha^{f_1}_{\langle s_2,s_3\rangle} = \left(\alpha^{f_3}_{s_0}\right)' + \left(\alpha^{f_0}_{s_1}\right)' + \left(\alpha^{f_1}_{s_2}\right)'$
- $\alpha^{x(f_0)}_{s_3} = \left(\alpha^{x(f_0)}_{s_0}\right)' + \left(\alpha_{s_0} - \alpha^{x(f_1)}_{s_0}\right)' = \left(\left(\alpha^{f_3}\right)'\right)' + \left(\alpha^{f_1}\right)'$
- $\alpha^{x(f_3)}_{s_3} = \alpha_{s_3} - \alpha^{f_3}_{s_3} = \left(\alpha^{f_3}_{\langle s_0,s_3\rangle} + \alpha^{f_0}_{\langle s_1,s_3\rangle} + \alpha^{f_1}_{\langle s_2,s_3\rangle}\right) - \alpha^{f_3}_{\langle s_0,s_3\rangle} = \alpha^{f_0}_{\langle s_1,s_3\rangle} + \alpha^{f_1}_{\langle s_2,s_3\rangle}$

- $\beta^{\text{l.o.}f_0}_{s_0} = \left(\beta_{s_0} \ominus \alpha^{x(f_0)}_{s_0}\right) = \left(\beta_{s_0} \ominus \left(\alpha^{f_3}_{s_2}\right)'\right) = \left(\beta_{s_0} \ominus \left(\alpha^{f_3} \oslash \beta^{\text{l.o.}f_3}_{s_2}\right)\right)$
- $\beta^{\text{l.o.}f_0}_{\text{e2e}} = \beta^{\text{l.o.}f_0}_{s_0} \otimes \beta^{\text{l.o.}f_0}_{s_1} \otimes \beta^{\text{l.o.}f_0}_{s_3} = \left(\beta_{s_0} \ominus \alpha^{x(f_0)}_{s_0}\right) \otimes \left(\beta_{s_2} \ominus \alpha^{x(f_0)}_{s_2}\right) \otimes \left(\beta_{s_3} \ominus \alpha^{x(f_0)}_{s_3}\right)$
- $\beta^{\text{l.o.}f_0}_{\text{e2e}} = \beta^{\text{l.o.}f_0}_{\langle s_0,s_3\rangle} = \beta^{\text{l.o.}f_0}_{\langle s_0,s_1\rangle} \otimes \beta^{\text{l.o.}f_0}_{s_3}$
- $\beta_{\langle s_0,s_1\rangle} = \beta_{s_0} \otimes \beta_{s_1} = \bigotimes_{i=0}^{1} \beta_{s_i}$
- $\beta^{f_3}_{P(f_3)} = \beta^{f_3}_{\langle s_2,s_3\rangle} = \beta_{s_2} \otimes \beta_{s_0} \otimes \beta_{s_3} = \bigotimes_{i=\{2,0,3\}} \beta_{s_i}$