chain-replication-acks[13,45]

chain-replication-acks{i:l}
$(es;\ Cmd;\ Rsp;\ isupdate;\ In;\ Out;\ Sys;\ Ack;\ f;\ g;\ Delta;\ Q)$
$\equiv_{\text{def}}$ fifo-antecedent(es;Sys;f) & fifo-antecedent(es;Ack;g)
& $(\forall u{:}\mathrm{E}(Sys).\ (f(u) = u) \Longleftrightarrow (\uparrow(u \in_b In)))$
& $(\mathrm{E}(In) \subseteq\mathrm{r}\ \mathrm{E}(Sys))$
& $(\mathrm{E}(Out) \subseteq\mathrm{r}\ \mathrm{E}(Sys))$
& $(\mathrm{E}(Out) \subseteq\mathrm{r}\ \mathrm{E}(Ack))$
& $(\forall e{:}\mathrm{E}(In).\ (\neg(\uparrow(isupdate(In(e))))) \Rightarrow (\uparrow(e \in_b Out)))$
& $(\forall e{:}\mathrm{E}(Sys).\ (\neg(\uparrow(e \in_b In))) \Rightarrow (\mathrm{loc}(f(e)) = \mathrm{loc}(e)) \Rightarrow (\neg(\uparrow(e \in_b Out))))$
& input-forwarding{i:l}
$(es;\ Cmd;\ Sys;\ isupdate;\ In;\ f)$
& $(\exists chain{:}\{e{:}\mathrm{E}|\ (\uparrow(e \in_b Sys)) \vee (\uparrow(e \in_b Ack))\} \rightarrow$(Id List)
(chain-config(es;p-conditional(Ack; Sys);$chain$)
& chain-consistent(f;$chain$)
& $(\forall e{:}\mathrm{E}(Ack).$
$(\neg(\mathrm{loc}(g(e)) = \mathrm{loc}(e)))$
$\Rightarrow$ (adjacent(Id;$chain(e)$;loc(e);loc($g(e)$))
& adjacent(Id;$chain(g(e))$;loc(e);loc($g(e)$)))))))
& $(\forall e{:}\mathrm{E}(Ack).\ (\mathrm{loc}(g(e)) = \mathrm{loc}(e)) \Rightarrow (\uparrow(e \in_b Out)))$
& $(\forall e{:}\mathrm{E}(Ack).\ (\uparrow(e \in_b Out)) \Rightarrow (g(e) = e))$
& $(\forall e{:}\mathrm{E}(Ack).\ (\uparrow((g(e)) \in_b Out)) \Rightarrow$ is-query(In;$isupdate$;$g(e)$) $\Rightarrow (g(e) = e))$
& $(\forall e{:}\mathrm{E}(Out).$
(is-query(In;$isupdate$;e)
$\Rightarrow (Out(e) = Q($filter($isupdate$;es-interface-history(es; Sys; e)),$In(e)))$)
& ((¬is-query(In;$isupdate$;e))
$\Rightarrow (Out(e) = Delta($filter($isupdate$;es-interface-history($es$; Sys; e))))))
& $(\forall e{:}\mathrm{E}(Ack).$
$Ack(e) =$ if $e \in_b Out$ then $\|$filter($isupdate$;$Sys(e)$)$\|$ else $Ack(g(e))$ fi)

clarification:

chain-replication-acks{i:l}
$(es;\ Cmd;\ Rsp;\ isupdate;\ In;\ Out;\ Sys;\ Ack;\ f;\ g;\ Delta;\ Q)$
$\equiv_{\text{def}}$ fifo-antecedent(es;Sys;f) & fifo-antecedent(es;Ack;g)
& $(\forall u{:}$es-E-interface(es;Sys). $(f(u) = u \in$ es-E(es)) $\Longleftrightarrow (\uparrow(u \in_b In)))$
& (es-E-interface(es;In) $\subseteq$r es-E-interface(es;Sys))
& (es-E-interface(es;Out) $\subseteq$r es-E-interface(es;Sys))
& (es-E-interface(es;Out) $\subseteq$r es-E-interface(es;Ack))
& $(\forall e{:}$es-E-interface(es;In). $(\neg(\uparrow(isupdate(In(e))))) \Rightarrow (\uparrow(e \in_b Out)))$
& $(\forall e{:}$es-E-interface(es;Sys).
$(\neg(\uparrow(e \in_b In))) \Rightarrow$ (es-loc(es; $(f(e))$) = es-loc(es; e) $\in$ Id) $\Rightarrow (\neg(\uparrow(e \in_b Out))))$
& input-forwarding{i:l}

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\begin{array}{l}
\qquad\qquad\qquad (es;\ Cmd;\ Sys;\ isupdate;\ In;\ f) \\
\&\ (\exists chain{:}\{e{:}\text{es-E}(es)|\ (\uparrow(e \in_b Sys)) \vee (\uparrow(e \in_b Ack))\} \rightarrow (\text{Id List}) \\
\quad (\text{chain-config}(es;\text{p-conditional}(Ack;\ Sys);chain) \\
\quad \&\ \text{chain-consistent}(es;Sys;In;isupdate;Out;f;chain) \\
\quad \&\ (\forall e{:}\text{es-E-interface}(es;Ack). \\
\qquad (\neg(\text{es-loc}(es;\ (g(e))) = \text{es-loc}(es;\ e) \in \text{Id})) \\
\qquad \Rightarrow (\text{adjacent}(\text{Id};chain(e);\text{es-loc}(es;\ e);\text{es-loc}(es;\ (g(e)))) \\
\qquad\quad \&\ \text{adjacent}(\text{Id};chain(g(e));\text{es-loc}(es;\ e);\text{es-loc}(es;\ (g(e))))))) \\
\&\ (\forall e{:}\text{es-E-interface}(es;Ack). \\
\quad (\text{es-loc}(es;\ (g(e))) = \text{es-loc}(es;\ e) \in \text{Id}) \Rightarrow (\uparrow(e \in_b Out))) \\
\&\ (\forall e{:}\text{es-E-interface}(es;Ack).\ (\uparrow(e \in_b Out)) \Rightarrow (g(e) = e \in \text{es-E}(es))) \\
\&\ (\forall e{:}\text{es-E-interface}(es;Ack). \\
\quad (\uparrow((g(e)) \in_b Out)) \Rightarrow \text{is-query}(In;isupdate;g(e)) \Rightarrow (g(e) = e \in \text{es-E}(es))) \\
\&\ (\forall e{:}\text{es-E-interface}(es;Out). \\
\quad (\text{is-query}(In;isupdate;e) \\
\quad\ \Rightarrow (Out(e) = Q(\text{filter}(isupdate;\text{es-interface-history}(es;\ Sys;\ e)),In(e)) \in Rsp)) \\
\quad \&\ ((\neg\text{is-query}(In;isupdate;e)) \\
\qquad \Rightarrow (Out(e) = Delta(\text{filter}(isupdate;\text{es-interface-history}(es;\ Sys;\ e))) \in Rsp))) \\
\&\ (\forall e{:}\text{es-E-interface}(es;Ack). \\
\quad Ack(e) = \text{if } e \in_b Out \text{ then } \|\text{filter}(isupdate;Sys(e))\| \text{ else } Ack(g(e)) \text{ fi} \in \mathbb{Z})
\end{array}
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http://www.nuprl.org/FDLcontent/p0_963683_/p0_356716_{chain-replication-acks}.html