```
frame-rule  THM

⊢  ∀i:Id, L:Knd List, x:Id, T:Type.
|  @i: only L affects x : T
|  realizes es.(vartype(i;x) ⊆r T)
|              & (∀e:E.
|                 loc(e) = i
|                 ⇒
|                 (¬(x after e) = (x when e) ⇒ (kind(e) ∈ L))
|                 & (¬(kind(e) ∈ L) ⇒ (x after e) = (x when e)))
| by Auto THEN Try (Parallel0p 1)
|    THEN
|    BackThru
|    Thm* ∀D:Dsys, P:({es:ES| es is an event system of D }→Prop{i'}).
|         D realizes2 es.P(es) ⇒ D realizes es.P(es)
|    {d_DASH_realizes2_DASH_implies_DASH_realizes}
|    THENA
|    Try (Complete Auto)
|
|\
| .....wf .....
| 1. i : Id
| 2. L : Knd List
| 3. x : Id
| 4. T : Type
| ⊢  (λes.(vartype(i;x) ⊆r T)
|     & (∀e:E.
|        loc(e) = i
|        ⇒
|        (¬(x after e) = (x when e) ⇒ (kind(e) ∈ L))
|        & (¬(kind(e) ∈ L) ⇒ (x after e) = (x when e))))
|    ∈ {es:ES| es is an event system of @i: only L affects x : T }→
|      Prop
|   by Analyze THEN Analyze -1 THEN Analyze -1 THEN ExRepD
|      THEN
|      Try DoSubsume
|      THEN
|      Try (HypSubst -1 0)
|      THEN
|      Try (HypSubst -2 0)
|
.\
. 1. i : Id
. 2. L : Knd List
. 3. x : Id
. 4. T : Type
. ⊢  @i: only L affects x : T realizes2 es.(vartype(i;x) ⊆r T)
. |  & (∀e:E.
. |     loc(e) = i
. |     ⇒
. |     (¬(x after e) = (x when e) ⇒ (kind(e) ∈ L))
. |     & (¬(kind(e) ∈ L) ⇒ (x after e) = (x when e)))
. | by let T ≡ Auto THEN D_ES_Subtype THEN ExRepD in
. |    RepeatFor 3 (Analyze 0 THENA Complete Auto) THEN ES_Reduce
. |    THEN
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. |    PW_Reduce -1
. |    THENA
. |    T
. |
. 1. i : Id
. 2. L : Knd List
. 3. x : Id
. 4. T : Type
. 5. w : World
. 6. FairFifo
. 7. FairFifo
. 8. ∀i@0,x@0:Id.
. |  vartype(i@0;x@0) ⊆r if deq-member(IdDeq;x@0;1of(1of(
. |                                                 if eqof(...)(i@0,i)→
. |                                                    <<[x],λx.T>
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,<[x],λx.L>
. |                                                    ,
. |                                                    ,·>
. |                                                 else  fi)))→
. |                          2of(1of(if eqof(IdDeq)(i@0,i)→
. |                                     <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                                  else  fi))
. |                          (x@0)
. |                       else Top fi
. 9. ∀i@0:Id, a:Action(i@0).
. |  ¬isnull(a)
. |  ⇒
. |  (valtype(i@0;a) ⊆r if eqof(IdDeq)(i@0,i)→
. |                        <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                     else  fi.da(kind(a)))
. 10. ∀l:IdLnk, tg:Id.
. |   (w.M(l,tg)) ⊆r if eqof(IdDeq)(source(l),i)→
. |                     <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                  else  fi.da(rcv(l; tg))
. 11. ∀i@0,x@0:Id.
. |   deq-member(IdDeq;x@0;1of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                                          <<[x],λx.T>
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,<[x],λx.L>
. |                                          ,
. |                                          ,·>
. |                                       else  fi)))))
. |   ⇒
. |   s(i@0;0).x@0
. |   =
. |   2of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
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. |                      <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. |                  else  fi))))
. |   (x@0)
. 12. ∀i@0:Id, t:ℕ.
. |   ¬isnull(a(i@0;t))
. |   ⇒
. |   (islocal(kind(a(i@0;t)))
. |    ⇒
. |    deq-member(IdDeq;act(kind(a(i@0;t)));1of(1of(2of(2of(2of(
. |                                                 if eqof(IdDeq)
. |                                                    (i@0
. |                                                    ,i)→
. |                                                    <<[x],λx.T>
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,<[x],λx.L>
. |                                                    ,
. |                                                    ,•>
. |                                                 else  fi))))))
. |    ⇒
. |    2of(1of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                            <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. |                       else  fi)))))
. |    (act(kind(a(i@0;t)))
. |    ,λx.s(i@0;t).x
. |    ,val(a(i@0;t))))
. |   & (∀x@0:Id.
. |      deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i@0;t))
. |                                                    ,x@0>;1of(1of(
. |                                                          2of(2of(
. |                                                          2of(2of(
. |                                                          ...)))))))
. |      ⇒
. |      s(i@0;t+1).x@0
. |      =
. |      2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                                  <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. |                             else  fi))))))
. |      (<kind(a(i@0;t)),x@0>
. |      ,λx.s(i@0;t).x
. |      ,val(a(i@0;t))))
. |   & (∀l:IdLnk.
. |      deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(...)
. |                                                         ,l>;...)
. |      ⇒
. |      withlnk(l;m(i@0;t))
. |      =
. |      if source(l) = i@0→
. |         concat(map(λtgf.map(λx.
. |         <1of(tgf),x>;2of(tgf)
. |                       ((λx.s(i@0;t).x)
. |                       ,val(a(i@0;t))));2of(1of(2of(2of(2of(2of(2of(
```

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. |                                                 if eqof(IdDeq)
. |                                                    (i@0
. |                                                    ,i)→
. |                                                    <<[x],λx.T>
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,<[x],λx.L>
. |                                                    ,
. |                                                    ,·>
. |                                                 else  fi)))))))
. |                                           (<kind(a(i@0;t)),l>)))
. |      else nil fi)
. |   & (∀x@0:Id.
. |      ¬(deq-member(IdDeq;x@0;1of(1of(2of(2of(2of(2of(2of(2of(2of(
. |                                        if eqof(IdDeq)(i@0,i)→
. |                                           <<[x],λx.T>
. |                                           ,
. |                                           ,
. |                                           ,
. |                                           ,
. |                                           ,
. |                                           ,<[x],λx.L>
. |                                           ,
. |                                           ,·>
. |                                        else  fi)))))))))
. |        ⇒
. |        deq-member(KindDeq;kind(a(i@0;t));2of(1of(2of(2of(2of(2of(2of(
. |                                                    2of(2of(
. |                                                    if eqof(IdDeq)
. |                                                       (i@0
. |                                                       ,i)→
. |                                                       <<[x],λx.T>
. |                                                       ,
. |                                                       ,
. |                                                       ,
. |                                                       ,
. |                                                       ,
. |                                                       ,<[x],λx.L>
. |                                                       ,
. |                                                       ,·>
. |                                                    else  fi)))))))))
. |                                              (x@0)))
. |      ⇒
. |      s(i@0;t).x@0 = s(i@0;t+1).x@0)
. |   & (∀l:IdLnk, tg:Id.
. |      ¬(deq-member(product-deq(IdLnk;Id;IdLnkDeq;IdDeq);<l
. |                                                         ,tg>;...)
. |        ⇒
. |        deq-member(KindDeq;kind(a(i@0;t));2of(1of(2of(2of(2of(2of(2of(
. |                                                    2of(2of(2of(
. |                                                    if eqof(IdDeq)
. |                                                       (i@0
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. |                                                    ,i)→
. |                                                    <<[x],λx.T>
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,
. |                                                    ,<[x],λx.L>
. |                                                    ,
. |                                                    ,·>
. |                                                 else  fi)))))))))
. |                                           (<l,tg>)))
. |      ⇒
. |      w-tagged(tg; onlnk(l;m(i@0;t))) = nil)
. 13. ∀i@0,a:Id, t:ℕ.
. |   ∃t':ℕ.
. |   t≤t'
. |   & ¬isnull(a(i@0;t')) & kind(a(i@0;t')) = locl(a)
. |     ∨ ¬a declared in if eqof(IdDeq)(i@0,i)→
. |                         <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                      else  fi
. |     ∨ unsolvable if eqof(IdDeq)(i@0,i)→
. |                     <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                  else  fi.pre(a,λx.s(i@0;t').x)
. ⊢  (vartype(i;x) ⊆r T)
. |  & (∀e:E.
. |     loc(e) = i
. |     ⇒
. |     (¬(x after e) = (x when e) ⇒ (kind(e) ∈ L))
. |     & (¬(kind(e) ∈ L) ⇒ (x after e) = (x when e)))
. | by Thin -1 THEN Analyze 0
. |
. |\
. | 1. i : Id
. | 2. L : Knd List
. | 3. x : Id
. | 4. T : Type
. | 5. w : World
. | 6. FairFifo
. | 7. FairFifo
. | 8. ∀i@0,x@0:Id.
. |    vartype(i@0;x@0) ⊆r if deq-member(IdDeq;x@0;1of(1of(
. |                                                  if eqof(IdDeq)
. |                                                     (i@0
. |                                                     ,i)→
. |                                                     <<[x],λx.T>
. |                                                     ,
. |                                                     ,
. |                                                     ,
. |                                                     ,
. |                                                     ,
. |                                                     ,<[x],λx.L>
. |                                                     ,
. |                                                     ,·>
. |                                                  else  fi)))→
```

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. |                          2of(1of(if eqof(IdDeq)(i@0,i)→
. |                                    <<[x],λx.T>
. |                                    ,
. |                                    ,
. |                                    ,
. |                                    ,
. |                                    ,
. |                                    ,<[x],λx.L>
. |                                    ,
. |                                    ,·>
. |                                 else  fi))
. |                           (x@0)
. |                        else Top fi
. | 9. ∀i@0:Id, a:Action(i@0).
. |    ¬isnull(a)
. |    ⇒
. |    (valtype(i@0;a) ⊆r if eqof(IdDeq)(i@0,i)→
. |                          <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                       else  fi.da(kind(a)))
. | 10. ∀l:IdLnk, tg:Id.
. |     (w.M(l,tg)) ⊆r if eqof(IdDeq)(source(l),i)→
. |                       <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                    else  fi.da(rcv(l; tg))
. | 11. ∀i@0,x@0:Id.
. |     deq-member(IdDeq;x@0;1of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                                             <<[x],λx.T>
. |                                             ,
. |                                             ,
. |                                             ,
. |                                             ,
. |                                             ,<[x],λx.L>
. |                                             ,
. |                                             ,·>
. |                                          else  fi)))))
. |     ⇒
. |     s(i@0;0).x@0
. |     =
. |     2of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                        <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                     else  fi))))
. |     (x@0)
. | 12. ∀i@0:Id, t:ℕ.
. |     ¬isnull(a(i@0;t))
. |     ⇒
. |     (islocal(kind(a(i@0;t)))
. |      ⇒
. |      deq-member(IdDeq;act(kind(a(i@0;t)));1of(1of(2of(2of(2of(
. |                                                    if eqof(IdDeq)
. |                                                       (i@0
. |                                                       ,i)→
. |                                                       <<[x],λx.T>
. |                                                       ,
. |                                                       ,
. |                                                       ,
```

```
. |                                                          ,
. |                                                          ,
. |                                                          ,<[x],λx.L>
. |                                                          ,
. |                                                          ,·>
. |                                                    else  fi))))))
. |      ⇒
. |      2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                              <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                         else  fi)))))
. |      (act(kind(a(i@0;t)))
. |      ,λx.s(i@0;t).x
. |      ,val(a(i@0;t))))
. |     & (∀x@0:Id.
. |        deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(...)
. |                                                        ,x@0>;...)
. |        ⇒
. |        s(i@0;t+1).x@0
. |        =
. |        2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. |                                 <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. |                               else  fi))))))
. |        (<kind(a(i@0;t)),x@0>
. |        ,λx.s(i@0;t).x
. |        ,val(a(i@0;t))))
. |     & (∀l:IdLnk.
. |        deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<...
. |                                                            ,l>;...)
. |        ⇒
. |        withlnk(l;m(i@0;t))
. |        =
. |        if source(l) = i@0→
. |           concat(map(λtgf.map(λx.
. |           <1of(tgf)
. |           ,x>;2of(tgf)
. |               ((λx.s(i@0;t).x)
. |               ,val(a(i@0;t))));2of(1of(2of(2of(2of(2of(2of(
. |                                       if eqof(IdDeq)(i@0,i)→
. |                                          <<[x],λx.T>
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,<[x],λx.L>
. |                                          ,
. |                                          ,·>
. |                                       else  fi)))))))
. |                                  (<kind(a(i@0;t)),l>)))
. |        else nil fi)
. |     & (∀x@0:Id.
. |        ¬(deq-member(IdDeq;x@0;1of(1of(2of(2of(2of(2of(2of(2of(
. |                                       if eqof(IdDeq)(i@0,i)→
. |                                          <<[x],λx.T>
. |                                          ,
```

```
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,
. |                                          ,<[x],λx.L>
. |                                          ,
. |                                          ,·>
. |                                     else  fi)))))))))
. |          ⇒
. |          deq-member(KindDeq;kind(a(i@0;t));2of(
. |                                          1of(2of(2of(2of(2of(
. |                                              2of(2of(
. |                                              if eqof(IdDeq)
. |                                                 (i@0
. |                                                 ,i)⟶
. |                                                 <<[x],λx.T>
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,<[x],λx.L>
. |                                                 ,
. |                                                 ,·>
. |                                              else  fi)))))))))
. |                                          (x@0)))
. |        ⇒
. |        s(i@0;t).x@0 = s(i@0;t+1).x@0)
. |     & (∀l:IdLnk, tg:Id.
. |        ¬(deq-member(product-deq(IdLnk;Id;IdLnkDeq;IdDeq);...;...)
. |          ⇒
. |          deq-member(KindDeq;kind(a(i@0;t));2of(
. |                                          1of(2of(2of(2of(2of(
. |                                              2of(2of(2of(
. |                                              if eqof(IdDeq)
. |                                                 (i@0
. |                                                 ,i)⟶
. |                                                 <<[x],λx.T>
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,
. |                                                 ,<[x],λx.L>
. |                                                 ,
. |                                                 ,·>
. |                                              else  fi)))))))))
. |                                          (<l,tg>)))
. |        ⇒
. |        w-tagged(tg; onlnk(l;m(i@0;t))) = nil)
. | ⊢  vartype(i;x) ⊆r T
. |   by AllHyps (λj.InstHyp [i;x] j THENA Complete Auto)
. |      THEN
. |      AllHyps
. |      (λh.
```

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. |       Repeat
. |       (RWO
. |        Thm* ∀d:EqDecider(A), i:A. (eqof(d)(i,i)) ∼ true₂
. |        {eqof_eq_btrue}
. |        h
. |        THEN
. |        Reduce h))
. |
. .\
. . 1. i : Id
. . 2. L : Knd List
. . 3. x : Id
. . 4. T : Type
. . 5. w : World
. . 6. FairFifo
. . 7. FairFifo
. . 8. ∀i@0,x@0:Id.
. . |  vartype(i@0;x@0) ⊆r if deq-member(IdDeq;x@0;1of(1of(
. . |                                                 if eqof(IdDeq)
. . |                                                    (i@0
. . |                                                    ,i)→
. . |                                                    <<[x],λx.T>
. . |                                                    ,
. . |                                                    ,
. . |                                                    ,
. . |                                                    ,
. . |                                                    ,
. . |                                                    ,<[x],λx.L>
. . |                                                    ,
. . |                                                    ,·>
. . |                                                 else  fi)))→
. . |                          2of(1of(if eqof(IdDeq)(i@0,i)→
. . |                                     <<[x],λx.T>
. . |                                     ,
. . |                                     ,
. . |                                     ,
. . |                                     ,
. . |                                     ,
. . |                                     ,<[x],λx.L>
. . |                                     ,
. . |                                     ,·>
. . |                                  else  fi))
. . |                             (x@0)
. . |                        else Top fi
. . 9. ∀i@0:Id, a:Action(i@0).
. . |  ¬isnull(a)
. . |  ⇒
. . |  (valtype(i@0;a) ⊆r if eqof(IdDeq)(i@0,i)→
. . |                         <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. . |                      else  fi.da(kind(a)))
. . 10. ∀l:IdLnk, tg:Id.
. . |   (w.M(l,tg)) ⊆r if eqof(IdDeq)(source(l),i)→
. . |                      <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. . |                   else  fi.da(rcv(l; tg))
. . 11. ∀i@0,x@0:Id.
```

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. . |   deq-member(IdDeq;x@0;1of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                                          <<[x],λx.T>
. . |                                          ,
. . |                                          ,
. . |                                          ,
. . |                                          ,
. . |                                          ,
. . |                                          ,<[x],λx.L>
. . |                                          ,
. . |                                          ,·>
. . |                                       else  fi)))))
. . |   ⇒
. . |   s(i@0;0).x@0
. . |   =
. . |   2of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                      <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. . |                   else  fi))))
. . |   (x@0)
. . 12. ∀i@0:Id, t:ℕ.
. . |   ¬isnull(a(i@0;t))
. . |   ⇒
. . |   (islocal(kind(a(i@0;t)))
. . |    ⇒
. . |    deq-member(IdDeq;act(kind(a(i@0;t)));1of(1of(2of(2of(2of(
. . |                                                  if eqof(IdDeq)
. . |                                                     (i@0
. . |                                                     ,i)→
. . |                                                     <<[x],λx.T>
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,<[x],λx.L>
. . |                                                     ,
. . |                                                     ,·>
. . |                                                  else  fi))))))
. . |    ⇒
. . |    2of(1of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                           <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. . |                        else  fi)))))
. . |    (act(kind(a(i@0;t)))
. . |    ,λx.s(i@0;t).x
. . |    ,val(a(i@0;t))))
. . |   & (∀x@0:Id.
. . |      deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(...)
. . |                                                    ,x@0>;...)
. . |      ⇒
. . |      s(i@0;t+1).x@0
. . |      =
. . |      2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                                  <<[x],λx.T>,,,,,,<[x],λx.L>,,·>
. . |                               else  fi))))))
. . |      (<kind(a(i@0;t)),x@0>
. . |      ,λx.s(i@0;t).x
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```
. . |      ,val(a(i@0;t))))
. . |   & (∀l:IdLnk.
. . |      deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<...
. . |                                                          ,l>;...)
. . |      ⇒
. . |      withlnk(l;m(i@0;t))
. . |      =
. . |      if source(l) = i@0→
. . |         concat(map(λtgf.map(λx.
. . |         <1of(tgf)
. . |         ,x>;2of(tgf)
. . |             ((λx.s(i@0;t).x)
. . |             ,val(a(i@0;t))));2of(1of(2of(2of(2of(2of(2of(
. . |                                      if eqof(IdDeq)(i@0,i)→
. . |                                         <<[x],λx.T>
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,<[x],λx.L>
. . |                                         ,
. . |                                         ,·>
. . |                                       else  fi)))))))
. . |                                (<kind(a(i@0;t)),l>)))
. . |      else nil fi)
. . |   & (∀x@0:Id.
. . |      ¬(deq-member(IdDeq;x@0;1of(1of(2of(2of(2of(2of(2of(2of(
. . |                                      if eqof(IdDeq)(i@0,i)→
. . |                                         <<[x],λx.T>
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,<[x],λx.L>
. . |                                         ,
. . |                                         ,·>
. . |                                       else  fi)))))))))
. . |        ⇒
. . |        deq-member(KindDeq;kind(a(i@0;t));2of(
. . |                                          1of(2of(2of(2of(2of(
. . |                                              2of(2of(
. . |                                              if eqof(IdDeq)
. . |                                                 (i@0
. . |                                                 ,i)→
. . |                                                 <<[x],λx.T>
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,<[x],λx.L>
. . |                                                 ,
. . |                                                 ,·>
```

```
. . |                                              else  fi)))))))))
. . |                                          (x@0)))
. . |      ⇒
. . |      s(i@0;t).x@0 = s(i@0;t+1).x@0)
. . |   & (∀l:IdLnk, tg:Id.
. . |      ¬(deq-member(product-deq(IdLnk;Id;IdLnkDeq;IdDeq);...;...)
. . |        ⇒
. . |        deq-member(KindDeq;kind(a(i@0;t));2of(
. . |                                          1of(2of(2of(2of(2of(
. . |                                              2of(2of(2of(
. . |                                              if eqof(IdDeq)
. . |                                                 (i@0
. . |                                                 ,i)⟶
. . |                                                 <<[x],λx.T>
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,
. . |                                                 ,<[x],λx.L>
. . |                                                 ,
. . |                                                 ,·>
. . |                                              else  fi)))))))))
. . |                                          (<l,tg>)))
. . |      ⇒
. . |      w-tagged(tg; onlnk(l;m(i@0;t))) = nil)
. . 13. vartype(i;x) ⊆r T
. . ⊢  ∀e:E.
. . |  loc(e) = i
. . |  ⇒
. . |  (¬(x after e) = (x when e) ⇒ (kind(e) ∈ L))
. . |  & (¬(kind(e) ∈ L) ⇒ (x after e) = (x when e))
. . | by Repeat
. . |    (Unfolds [‘es-E‘;‘es-loc‘;‘es-first‘;‘es-when‘;‘es-Loc‘] 0
. . |     THEN
. . |     Reduce 0)
. . |    THEN
. . |    Analyze 0
. . |    THEN
. . |    DVar ‘e’
. . |    THEN
. . |    DVar ‘e’
. . |    THEN
. . |    Repeat
. . |    (Unfolds [‘w-loc‘;‘w-when‘;‘w-after‘;‘w-ekind‘;‘w-act‘] 0
. . |     THEN
. . |     Reduce 0)
. . |    THEN
. . |    Analyze 0
. . |    THENA
. . |    (Auto THEN D_ES_Subtype)
. . |    THEN
. . |    All Reduce
. . |
. . 1. i : Id
```

```
. . 2. L : Knd List
. . 3. x : Id
. . 4. T : Type
. . 5. w : World
. . 6. FairFifo
. . 7. FairFifo
. . 8. ∀i@0,x@0:Id.
. . |  vartype(i@0;x@0) ⊆r if deq-member(IdDeq;x@0;1of(1of(
. . |                                                  if eqof(IdDeq)
. . |                                                     (i@0
. . |                                                     ,i)→
. . |                                                     <<[x],λx.T>
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,<[x],λx.L>
. . |                                                     ,
. . |                                                     ,·>
. . |                                                  else  fi)))→
. . |                           2of(1of(if eqof(IdDeq)(i@0,i)→
. . |                                      <<[x],λx.T>
. . |                                      ,
. . |                                      ,
. . |                                      ,
. . |                                      ,
. . |                                      ,
. . |                                      ,<[x],λx.L>
. . |                                      ,
. . |                                      ,·>
. . |                                   else  fi))
. . |                            (x@0)
. . |                         else Top fi
. . 9. ∀i@0:Id, a:Action(i@0).
. . |  ¬isnull(a)
. . |  ⇒
. . |  (valtype(i@0;a) ⊆r if eqof(IdDeq)(i@0,i)→
. . |                           <<[x],λx.T>,,,,,,,<[x],λx.L>,,·>
. . |                      else  fi.da(kind(a)))
. . 10. ∀l:IdLnk, tg:Id.
. . |   (w.M(l,tg)) ⊆r if eqof(IdDeq)(source(l),i)→
. . |                      <<[x],λx.T>,,,,,,,<[x],λx.L>,,·>
. . |                   else  fi.da(rcv(l; tg))
. . 11. ∀i@0,x@0:Id.
. . |   deq-member(IdDeq;x@0;1of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                                            <<[x],λx.T>
. . |                                            ,
. . |                                            ,
. . |                                            ,
. . |                                            ,
. . |                                            ,
. . |                                            ,<[x],λx.L>
. . |                                            ,
. . |                                            ,·>
```

```
. . |                                          else  fi)))))
. . |   ⇒
. . |   s(i@0;0).x@0
. . |   =
. . |   2of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                      <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. . |                  else  fi))))
. . |   (x@0)
. . 12. ∀i@0:Id, t:ℕ.
. . |   ¬isnull(a(i@0;t))
. . |   ⇒
. . |   (islocal(kind(a(i@0;t)))
. . |    ⇒
. . |    deq-member(IdDeq;act(kind(a(i@0;t)));1of(1of(2of(2of(2of(
. . |                                                  if eqof(IdDeq)
. . |                                                     (i@0
. . |                                                     ,i)→
. . |                                                     <<[x],λx.T>
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,<[x],λx.L>
. . |                                                     ,
. . |                                                     ,•>
. . |                                                  else  fi))))))
. . |    ⇒
. . |    2of(1of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                           <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. . |                       else  fi)))))
. . |    (act(kind(a(i@0;t)))
. . |    ,λx.s(i@0;t).x
. . |    ,val(a(i@0;t))))
. . |   & (∀x@0:Id.
. . |      deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(...)
. . |                                                    ,x@0>;...)
. . |      ⇒
. . |      s(i@0;t+1).x@0
. . |      =
. . |      2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
. . |                                 <<[x],λx.T>,,,,,,<[x],λx.L>,,•>
. . |                             else  fi))))))
. . |      (<kind(a(i@0;t)),x@0>
. . |      ,λx.s(i@0;t).x
. . |      ,val(a(i@0;t))))
. . |   & (∀l:IdLnk.
. . |      deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<...
. . |                                                          ,l>;...)
. . |      ⇒
. . |      withlnk(l;m(i@0;t))
. . |      =
. . |      if source(l) = i@0→
. . |         concat(map(λtgf.map(λx.
. . |         <1of(tgf)
```

```
. . |          ,x>;2of(tgf)
. . |              ((λx.s(i@0;t).x)
. . |              ,val(a(i@0;t))));2of(1of(2of(2of(2of(2of(2of(
. . |                                      if eqof(IdDeq)(i@0,i)→
. . |                                         <<[x],λx.T>
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,<[x],λx.L>
. . |                                         ,
. . |                                         ,·>
. . |                                      else  fi)))))))
. . |                                (<kind(a(i@0;t)),1>)))
. . |       else nil fi)
. . |    & (∀x@0:Id.
. . |       ¬(deq-member(IdDeq;x@0;1of(1of(2of(2of(2of(2of(2of(2of(
. . |                                      if eqof(IdDeq)(i@0,i)→
. . |                                         <<[x],λx.T>
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,
. . |                                         ,<[x],λx.L>
. . |                                         ,
. . |                                         ,·>
. . |                                      else  fi)))))))))
. . |         ⇒
. . |         deq-member(KindDeq;kind(a(i@0;t));2of(
. . |                                         1of(2of(2of(2of(2of(
. . |                                             2of(2of(
. . |                                             if eqof(IdDeq)
. . |                                                (i@0
. . |                                                ,i)→
. . |                                                <<[x],λx.T>
. . |                                                ,
. . |                                                ,
. . |                                                ,
. . |                                                ,
. . |                                                ,
. . |                                                ,<[x],λx.L>
. . |                                                ,
. . |                                                ,·>
. . |                                             else  fi)))))))))
. . |                                         (x@0)))
. . |       ⇒
. . |       s(i@0;t).x@0 = s(i@0;t+1).x@0)
. . |    & (∀l:IdLnk, tg:Id.
. . |       ¬(deq-member(product-deq(IdLnk;Id;IdLnkDeq;IdDeq);...;...)
. . |         ⇒
. . |         deq-member(KindDeq;kind(a(i@0;t));2of(
. . |                                         1of(2of(2of(2of(2of(
. . |                                             2of(2of(2of(
```

```
. . |                                                  if eqof(IdDeq)
. . |                                                     (i@0
. . |                                                     ,i)→
. . |                                                     <<[x],λx.T>
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,
. . |                                                     ,<[x],λx.L>
. . |                                                     ,
. . |                                                     ,·>
. . |                                                  else  fi)))))))))
. . |                                               (<l,tg>)))
. . |      ⇒
. . |      w-tagged(tg; onlnk(l;m(i@0;t))) = nil)
. . 13. vartype(i;x) ⊆r T
. . 14. e1 : Id
. . 15. e2 : ℕ
. . 16. ¬isnull(a(e1;e2))  [not for witness]
. . 17. e1 = i
. . ⊢  (¬s(e1;e2+1).x = s(e1;e2).x ⇒ (kind(a(e1;e2)) ∈ L))
. . |  & (¬(kind(a(e1;e2)) ∈ L) ⇒ s(e1;e2+1).x = s(e1;e2).x)
. . | by AssertBY (¬isnull(a(i;e2)))
. . |    (SupposeNot THEN Assert False THEN Unhide THEN Analyze -1
. . |     THEN
. . |     RevHypSubst -1 0)
. . |    THEN
. . |    InstHyp [i;e2] 12
. . |    THEN
. . |    RWO
. . |    Thm* ∀d:EqDecider(A), i:A. (eqof(d)(i,i)) ∼ true₂
. . |    {eqof_eq_btrue}
. . |    -1
. . |    THEN
. . |    Reduce -1
. . |    THEN
. . |    SplitAndHyps
. . |    THEN
. . |    SimpleInstHyp x -2
. . |    THEN
. . |    ThinForallHyps
. . |    THEN
. . |    RWO
. . |    Thm* ∀d:EqDecider(A), i:A. (eqof(d)(i,i)) ∼ true₂
. . |    {eqof_eq_btrue}
. . |    -1
. . |    THEN
. . |    Reduce -1
. . |    THEN
. . |    RWO
. . |    Thm* ∀eq:EqDecider(A), L:A List, x:A.
. . |         deq-member(eq;x;L) ⟺ (x ∈ L)
. . |    {assert_DASH_deq_DASH_member}
. . |    -1
```

```
. . |    THEN
. . |    Reduce -1
. . |    THEN
. . |    TrySubsume
. . |
. . 1. i : Id
. . 2. L : Knd List
. . 3. x : Id
. . 4. T : Type
. . 5. w : World
. . 6. FairFifo
. . 7. FairFifo
. . 8. vartype(i;x) ⊆r T
. . 9. e1 : Id
. . 10. e2 : ℕ
. . 11. ¬isnull(a(e1;e2))  [not for witness]
. . 12. e1 = i
. . 13. ¬isnull(a(i;e2))
. . 14. islocal(kind(a(i;e2)))
. . |   ⇒
. . |   deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . |   ⇒
. . |   2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . 15. ¬(True ⇒ (kind(a(i;e2)) ∈ L)) ⇒ s(i;e2).x = s(i;e2+1).x
. . ⊢  (¬s(e1;e2+1).x = s(e1;e2).x ⇒ (kind(a(e1;e2)) ∈ L))
. . |  & (¬(kind(a(e1;e2)) ∈ L) ⇒ s(e1;e2+1).x = s(e1;e2).x)
. . | by Assert Dec((kind(a(e1;e2)) ∈ L))
. . |
. . |\
. . | .....assertion .....
. . | 1. i : Id
. . | 2. L : Knd List
. . | 3. x : Id
. . | 4. T : Type
. . | 5. w : World
. . | 6. FairFifo
. . | 7. FairFifo
. . | 8. vartype(i;x) ⊆r T
. . | 9. e1 : Id
. . | 10. e2 : ℕ
. . | 11. ¬isnull(a(e1;e2))  [not for witness]
. . | 12. e1 = i
. . | 13. ¬isnull(a(i;e2))
. . | 14. islocal(kind(a(i;e2)))
. . |     ⇒
. . |     deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . |     ⇒
. . |     2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . | 15. ¬(True ⇒ (kind(a(i;e2)) ∈ L)) ⇒ s(i;e2).x = s(i;e2+1).x
. . | ⊢  Dec((kind(a(e1;e2)) ∈ L))
. . |   by AssertBY Dec(deq-member(KindDeq;kind(a(e1;e2));L)) Auto
. . |      THEN
. . |      RWO
. . |      Thm* ∀eq:EqDecider(A), L:A List, x:A.
. . |           deq-member(eq;x;L) ⟺ (x ∈ L)
```

```
. . |      {assert_DASH_deq_DASH_member}
. . |      -1
. . |
. . .\
. . . 1. i : Id
. . . 2. L : Knd List
. . . 3. x : Id
. . . 4. T : Type
. . . 5. w : World
. . . 6. FairFifo
. . . 7. FairFifo
. . . 8. vartype(i;x) ⊆r T
. . . 9. e1 : Id
. . . 10. e2 : ℕ
. . . 11. ¬isnull(a(e1;e2))  [not for witness]
. . . 12. e1 = i
. . . 13. ¬isnull(a(i;e2))
. . . 14. islocal(kind(a(i;e2)))
. . . |   ⇒
. . . |   deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . |   ⇒
. . . |   2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . 15. ¬(True ⇒ (kind(a(i;e2)) ∈ L)) ⇒ s(i;e2).x = s(i;e2+1).x
. . . 16. Dec((kind(a(e1;e2)) ∈ L))
. . . ⊢  (¬s(e1;e2+1).x = s(e1;e2).x ⇒ (kind(a(e1;e2)) ∈ L))
. . . |  & (¬(kind(a(e1;e2)) ∈ L) ⇒ s(e1;e2+1).x = s(e1;e2).x)
. . . | by Analyze -1 THEN Try (DoSubsume THEN Subst (e1 = i) 0)
. . . |
. . . |\
. . . | 1. i : Id
. . . | 2. L : Knd List
. . . | 3. x : Id
. . . | 4. T : Type
. . . | 5. w : World
. . . | 6. FairFifo
. . . | 7. FairFifo
. . . | 8. vartype(i;x) ⊆r T
. . . | 9. e1 : Id
. . . | 10. e2 : ℕ
. . . | 11. ¬isnull(a(e1;e2))  [not for witness]
. . . | 12. e1 = i
. . . | 13. ¬isnull(a(i;e2))
. . . | 14. islocal(kind(a(i;e2)))
. . . | |   ⇒
. . . | |   deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . | |   ⇒
. . . | |   2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . | 15. ¬(True ⇒ (kind(a(i;e2)) ∈ L)) ⇒ s(i;e2).x = s(i;e2+1).x
. . . | 16. ¬(kind(a(e1;e2)) ∈ L)
. . . | 17. ¬s(e1;e2+1).x = s(e1;e2).x
. . . | ⊢  (kind(a(e1;e2)) ∈ L)  by Analyze -3
. . . | |
. . . | |\
. . . | | .....antecedent .....
. . . | | 1. i : Id
```

```
. . . | | 2. L : Knd List
. . . | | 3. x : Id
. . . | | 4. T : Type
. . . | | 5. w : World
. . . | | 6. FairFifo
. . . | | 7. FairFifo
. . . | | 8. vartype(i;x) ⊆r T
. . . | | 9. e1 : Id
. . . | | 10. e2 : ℕ
. . . | | 11. ¬isnull(a(e1;e2))  [not for witness]
. . . | | 12. e1 = i
. . . | | 13. ¬isnull(a(i;e2))
. . . | | 14. islocal(kind(a(i;e2)))
. . . | |     ⇒
. . . | |     deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . | |     ⇒
. . . | |     2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . | | 15. ¬(kind(a(e1;e2)) ∈ L)
. . . | | 16. ¬s(e1;e2+1).x = s(e1;e2).x
. . . | | ⊢  ¬(True ⇒ (kind(a(i;e2)) ∈ L))
. . . | |   by Analyze 0 THEN ThinTrivial THEN Analyze -3
. . . | |      THEN
. . . | |      NthHypEq -1
. . . | |      THEN
. . . | |      Repeat Analyze
. . . | |
. . . | .\
. . . | . 1. i : Id
. . . | . 2. L : Knd List
. . . | . 3. x : Id
. . . | . 4. T : Type
. . . | . 5. w : World
. . . | . 6. FairFifo
. . . | . 7. FairFifo
. . . | . 8. vartype(i;x) ⊆r T
. . . | . 9. e1 : Id
. . . | . 10. e2 : ℕ
. . . | . 11. ¬isnull(a(e1;e2))  [not for witness]
. . . | . 12. e1 = i
. . . | . 13. ¬isnull(a(i;e2))
. . . | . 14. islocal(kind(a(i;e2)))
. . . | . |   ⇒
. . . | . |   deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . | . |   ⇒
. . . | . |   2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . | . 15. ¬(kind(a(e1;e2)) ∈ L)
. . . | . 16. ¬s(e1;e2+1).x = s(e1;e2).x
. . . | . 17. s(i;e2).x = s(i;e2+1).x
. . . | . ⊢  (kind(a(e1;e2)) ∈ L)  by Analyze -2 THEN Symmetry
. . . | . |
. . . | . .....assertion .....
. . . | . 1. i : Id
. . . | . 2. L : Knd List
. . . | . 3. x : Id
. . . | . 4. T : Type
```

```
. . . | . 5. w : World
. . . | . 6. FairFifo
. . . | . 7. FairFifo
. . . | . 8. vartype(i;x) ⊆r T
. . . | . 9. e1 : Id
. . . | . 10. e2 : ℕ
. . . | . 11. ¬isnull(a(e1;e2))
. . . | . 12. e1 = i
. . . | . 13. ¬isnull(a(i;e2))
. . . | . 14. islocal(kind(a(i;e2)))
. . . | .     ⇒
. . . | .     deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . | .     ⇒
. . . | .     2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . | . 15. ¬(kind(a(e1;e2)) ∈ L)
. . . | . 16. s(i;e2).x = s(i;e2+1).x
. . . | . ⊢  s(e1;e2).x = s(e1;e2+1).x
. . . | .   by StrongHypSubst -5 0 THEN DoSubsume THEN HypSubst -1 0
. . . |
. . . .\
. . . . 1. i : Id
. . . . 2. L : Knd List
. . . . 3. x : Id
. . . . 4. T : Type
. . . . 5. w : World
. . . . 6. FairFifo
. . . . 7. FairFifo
. . . . 8. vartype(i;x) ⊆r T
. . . . 9. e1 : Id
. . . . 10. e2 : ℕ
. . . . 11. ¬isnull(a(e1;e2))
. . . . 12. e1 = i
. . . . 13. ¬isnull(a(i;e2))
. . . . 14. islocal(kind(a(i;e2)))
. . . . |   ⇒
. . . . |   deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . . |   ⇒
. . . . |   2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . . 15. ¬(True ⇒ (kind(a(i;e2)) ∈ L)) ⇒ s(i;e2).x = s(i;e2+1).x
. . . . 16. ¬(kind(a(e1;e2)) ∈ L)
. . . . 17. ¬(kind(a(e1;e2)) ∈ L)
. . . . ⊢  s(e1;e2+1).x = s(e1;e2).x  by Analyze -3
. . . . |
. . . . |\
. . . . | .....antecedent .....
. . . . | 1. i : Id
. . . . | 2. L : Knd List
. . . . | 3. x : Id
. . . . | 4. T : Type
. . . . | 5. w : World
. . . . | 6. FairFifo
. . . . | 7. FairFifo
. . . . | 8. vartype(i;x) ⊆r T
. . . . | 9. e1 : Id
. . . . | 10. e2 : ℕ
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. . . . | 11. ¬isnull(a(e1;e2))
. . . . | 12. e1 = i

. . . . | 13. ¬isnull(a(i;e2))
. . . . | 14. islocal(kind(a(i;e2)))
. . . . |     ⇒
. . . . |     deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . . |     ⇒
. . . . |     2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . . | 15. ¬(kind(a(e1;e2)) ∈ L)
. . . . | 16. ¬(kind(a(e1;e2)) ∈ L)
. . . . | ⊢  ¬(True ⇒ (kind(a(i;e2)) ∈ L))
. . . . |   by Parallel0p -1 THEN ThinTrivial THEN NthHypEq -1
. . . . |      THEN
. . . . |      Repeat Analyze
. . . . |
. . . . .\
. . . . . 1. i : Id
. . . . . 2. L : Knd List
. . . . . 3. x : Id
. . . . . 4. T : Type
. . . . . 5. w : World
. . . . . 6. FairFifo
. . . . . 7. FairFifo
. . . . . 8. vartype(i;x) ⊆r T
. . . . . 9. e1 : Id
. . . . . 10. e2 : ℕ
. . . . . 11. ¬isnull(a(e1;e2))
. . . . . 12. e1 = i
. . . . . 13. ¬isnull(a(i;e2))
. . . . . 14. islocal(kind(a(i;e2)))
. . . . .     ⇒
. . . . .     deq-member(IdDeq;act(kind(a(i;e2)));1of())
. . . . .     ⇒
. . . . .     2of()(act(kind(a(i;e2))),λx.s(i;e2).x,val(a(i;e2)))
. . . . . 15. ¬(kind(a(e1;e2)) ∈ L)
. . . . . 16. ¬(kind(a(e1;e2)) ∈ L)
. . . . . 17. s(i;e2).x = s(i;e2+1).x
. . . . . ⊢  s(e1;e2+1).x = s(e1;e2).x
. . . . .   by StrongHypSubst -6 0 THEN DoSubsume THEN HypSubst -1 0
END
```