```
sframe-rule  THM

⊢  ∀i:Id, L:Knd List, l:IdLnk, tg:Id.
|  @i: only L sends on (l with tg)
|  realizes es.∀e:E.
|              loc(e) = i ⇒ ¬null(sends(l,tg,e)) ⇒ (kind(e) ∈ L)
| by Auto THEN Try (ParallelOp 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)
|
1. i : Id
2. L : Knd List
3. l : IdLnk
4. tg : Id
⊢  @i: only L sends on (l with tg) realizes2 es.∀e:E.
|  loc(e) = i ⇒ ¬null(sends(l,tg,e)) ⇒ (kind(e) ∈ L)
| by let T ≡ Auto THEN D_ES_Subtype THEN ExRepD in
|    RepeatFor 3 (Analyze 0 THENA Complete Auto) THEN ES_Reduce
|    THEN
|    PW_Reduce -1
|    THEN
|    RepeatFor 3 (Analyze 0 THENA Try T)
|
|\
| 1. i : Id
| 2. L : Knd List
| 3. l : IdLnk
| 4. tg : Id
| 5. w : World
| 6. FairFifo
| 7. FairFifo
| 8. ∀i@0,x:Id.
| |  vartype(i@0;x) ⊆r if deq-member(IdDeq;x;1of(1of(if eqof(IdDeq)
| |                                                        (i@0
| |                                                        ,i)→
| |                                                        <
| |                                                        ,
| |                                                        ,
| |                                                        ,
| |                                                        ,
| |                                                        ,
| |                                                        ,
| |                                                        ,<[<l,tg>]
| |                                                         ,λx.L>
| |                                                        ,·>
| |                                                     else  fi)))→
| |                          2of(1of(if eqof(IdDeq)(i@0,i)→
| |                                     <,,,,,,,<[<l,tg>],λx.L>,·>
| |                                  else  fi))
| |                          (x)
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| |                    else Top fi
| 9. ∀i@0:Id, a:Action(i@0).
| |  ¬isnull(a)
| |  ⇒
| |  (valtype(i@0;a) ⊆r if eqof(IdDeq)(i@0,i)→
| |                        <,,,,,,,<[<l,tg>],λx.L>,·>
| |                      else  fi.da(kind(a)))
| 10. ∀l@0:IdLnk, tg@0:Id.
| |   (w.M(l@0,tg@0)) ⊆r if eqof(IdDeq)(source(l@0),i)→
| |                        <,,,,,,,<[<l,tg>],λx.L>,·>
| |                      else  fi.da(rcv(l@0; tg@0))
| 11. ∀i@0,x:Id.
| |   deq-member(IdDeq;x;1of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
| |                                        <,,,,,,,<[<l,tg>],λx.L>,·>
| |                                      else  fi)))))
| |   ⇒
| |   s(i@0;0).x
| |   =
| |   2of(1of(2of(2of(if eqof(IdDeq)(i@0,i)→
| |                    <,,,,,,,<[<l,tg>],λx.L>,·>
| |                  else  fi))))
| |   (x)
| 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)→
| |                                                 <
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,<[<l,tg>]
| |                                                  ,λx.L>
| |                                                 ,·>
| |                                              else  fi))))))
| |    ⇒
| |    2of(1of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
| |                         <,,,,,,,<[<l,tg>],λx.L>,·>
| |                       else  fi)))))
| |    (act(kind(a(i@0;t)))
| |    ,λx.s(i@0;t).x
| |    ,val(a(i@0;t))))
| |   & (∀x:Id.
| |      deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i@0;t))
| |                                                ,x>;1of(1of(
| |                                                   2of(2of(2of(
| |                                                   2of(
| |                                                   ...)))))))
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```
| |       ⇒
| |       s(i@0;t+1).x
| |       =
| |       2of(1of(2of(2of(2of(2of(if eqof(IdDeq)(i@0,i)→
| |                                <,,,,,,,<[<l,tg>],λx.L>,·>
| |                             else  fi))))))
| |       (<kind(a(i@0;t)),x>
| |       ,λx.s(i@0;t).x
| |       ,val(a(i@0;t))))
| |    & (∀l@0:IdLnk.
| |       deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(...)
| |                                                          ,l@0>;...)
| |       ⇒
| |       withlnk(l@0;m(i@0;t))
| |       =
| |       if source(l@0) = 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)→
| |                                                 <
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,
| |                                                 ,<[<l,tg>],λx.L>
| |                                                 ,·>
| |                                              else  fi)))))))
| |                                       (<kind(a(i@0;t)),l@0>)))
| |       else nil fi)
| |    & (∀x:Id.
| |       ¬(deq-member(IdDeq;x;1of(1of(2of(2of(2of(2of(2of(2of(
| |                                   if eqof(IdDeq)(i@0,i)→
| |                                      <,,,,,,,<[<l,tg>],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)→
| |                                                    <
| |                                                    ,
| |                                                    ,
| |                                                    ,
| |                                                    ,
| |                                                    ,
| |                                                    ,
| |                                                    ,<[<l,tg>]
| |                                                     ,λx.L>
```

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| |                                                      ,·>
| |                                                   else  fi))))))))
| |                                           (x)))
| |      ⇒
| |      s(i@0;t).x = s(i@0;t+1).x)
| |   & (∀l@0:IdLnk, tg@0: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)→
| |                                                      <
| |                                                      ,
| |                                                      ,
| |                                                      ,
| |                                                      ,
| |                                                      ,
| |                                                      ,
| |                                                      ,<[<l,tg>]
| |                                                       ,λx.L>
| |                                                      ,·>
| |                                                   else  fi)))))))))
| |                                           (<l@0,tg@0>)))
| |      ⇒
| |      w-tagged(tg@0; onlnk(l@0;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)→
| |                          <,,,,,,,<[<l,tg>],λx.L>,·>
| |                       else  fi
| |     ∨ unsolvable if eqof(IdDeq)(i@0,i)→ <,,,,,,,<[<l,tg>],λx.L>,·>
| |                   else  fi.pre(a,λx.s(i@0;t').x)
| 14. e : E
| 15. loc(e) = i
| 16. ¬null(filter(λm.mtag(m) = tg;sends(l;e)))
| ⊢  (kind(e) ∈ L)
| | by Thin -4 THEN Analyze -3 THEN Analyze -4 THEN All Reduce
| |    THEN
| |    RenameVar ‘j’ -5
| |    THEN
| |    RenameVar ‘t’ -4
| |    THEN
| |    Decide isnull(a(j;t))
| |    THEN
| |    Try (Assert False THEN Unhide THEN Complete Auto)
| |
| 1. i : Id
| 2. L : Knd List
| 3. l : IdLnk
| 4. tg : Id
| 5. w : World
```

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

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

```
| |       else nil fi)
| |    & (∀x:Id.
| |       ¬(deq-member(IdDeq;x;1of(1of(2of(2of(2of(2of(2of(2of(
| |                                  if eqof(IdDeq)(i@0,i)→
| |                                     <,,,,,,,<[<l,tg>],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)→
| |                                                     <
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,<[<l,tg>]
| |                                                      ,λx.L>
| |                                                     ,·>
| |                                                  else  fi))))))))
| |                                          (x)))
| |       ⇒
| |       s(i@0;t).x = s(i@0;t+1).x)
| |    & (∀l@0:IdLnk, tg@0: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)→
| |                                                     <
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,
| |                                                     ,<[<l,tg>]
| |                                                      ,λx.L>
| |                                                     ,·>
| |                                                  else  fi)))))))))
| |                                          (<l@0,tg@0>)))
| |       ⇒
| |       w-tagged(tg@0; onlnk(l@0;m(i@0;t))) = nil)
| 13. j : Id
| 14. t : ℕ
| 15. ¬isnull(a(j;t))  [not for witness]
| 16. j = i
| 17. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| 18. ¬isnull(a(j;t))
| ⊢  (kind(<j,t>) ∈ L)
```

```
| | by Thin -4 THEN HypSubst -3 -1
| |    THEN
| |    AllHyps (λh.InstHyp [i;t] h THENA Complete Auto)
| |    THEN
| |    ThinForallHyps
| |    THEN
| |    Subst ((eqof(IdDeq)(i,i)) ~ true₂) -1
| |    THEN
| |    Reduce -1
| |    THEN
| |    Try
| |    (BackThru
| |     Thm* ∀d:EqDecider(A), i:A. (eqof(d)(i,i)) ~ true₂
| |     {eqof_eq_btrue})
| |    THEN
| |    ExRepD
| |

| 1. i : Id
| 2. L : Knd List
| 3. l : IdLnk
| 4. tg : Id
| 5. w : World
| 6. FairFifo
| 7. FairFifo
| 8. j : Id
| 9. t : ℕ
| 10. j = i
| 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| 12. ¬isnull(a(i;t))
| 13. islocal(kind(a(i;t)))
| |   ⇒
| |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| |   ⇒
| |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| 14. ∀x:Id.
| |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);...;1of())
| |   ⇒
| |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| 15. ∀l@0:IdLnk.
| |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(a(i;t))
| |                                                        ,l@0>;1of())
| |   ⇒
| |   withlnk(l@0;m(i;t))
| |   =
| |   if source(l@0) = i→
| |      concat(map(λtgf.map(λx.
| |      <1of(tgf),x>;2of(tgf)
| |                   ((λx.s(i;t).x)
| |                   ,val(a(i;t))));2of()(<kind(a(i;t)),l@0>)))
| |   else nil fi
| 16. ∀x:Id.
| |   ¬(deq-member(IdDeq;x;1of())
| |     ⇒
| |     deq-member(KindDeq;kind(a(i;t));2of()(x)))
| |   ⇒
```

```
| |   s(i;t).x = s(i;t+1).x
| 17. ∀l@0:IdLnk, tg@0:Id.
| |   ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))(<l,tg>,<l@0,tg@0>)
| |      ∨2 false2)
| |     ⇒
| |     deq-member(KindDeq;kind(a(i;t));L))
| |   ⇒
| |   w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| ⊢  (kind(<j,t>) ∈ L)
| | by Decide deq-member(KindDeq;kind(a(i;t));L)
| |    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. l : IdLnk
| | 4. tg : Id
| | 5. w : World
| | 6. FairFifo
| | 7. FairFifo
| | 8. j : Id
| | 9. t : ℕ
| | 10. j = i
| | 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| | 12. ¬isnull(a(i;t))
| | 13. islocal(kind(a(i;t)))
| | |   ⇒
| | |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| | |   ⇒
| | |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| | 14. ∀x:Id.
| | |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);...;1of())
| | |   ⇒
| | |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| | 15. ∀l@0:IdLnk.
| | |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(...)
| | |                                                       ,l@0>;1of(
| | |                                                             ))
| | |   ⇒
| | |   withlnk(l@0;m(i;t))
| | |   =
| | |   if source(l@0) = i→
| | |      concat(map(λtgf.map(λx.<1of(tgf)
| | |                          ,x>;2of(tgf)
| | |                              ((λx.s(i;t).x)
| | |                              ,val(a(i;t))));2of()
| | |                                             (<kind(a(i;t))
| | |                                              ,l@0>)))
| | |   else nil fi
| | 16. ∀x:Id.
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```
| | |   ¬(deq-member(IdDeq;x;1of())
| | |     ⇒
| | |     deq-member(KindDeq;kind(a(i;t));2of()(x)))
| | |   ⇒
| | |   s(i;t).x = s(i;t+1).x
| | 17. ∀l@0:IdLnk, tg@0:Id.
| | |   ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| | |      (<l,tg>
| | |      ,<l@0,tg@0>) ∨2 false2)
| | |     ⇒
| | |     deq-member(KindDeq;kind(a(i;t));L))
| | |   ⇒
| | |   w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| | 18. (kind(a(i;t)) ∈ L)
| | ⊢  (kind(<j,t>) ∈ L)
| | | by Unfold 'w-ekind' 0 THEN Unfold 'w-act' 0 THEN Reduce 0
| | |
| | 1. i : Id
| | 2. L : Knd List
| | 3. l : IdLnk
| | 4. tg : Id
| | 5. w : World
| | 6. FairFifo
| | 7. FairFifo
| | 8. j : Id
| | 9. t : ℕ
| | 10. j = i
| | 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| | 12. ¬isnull(a(i;t))
| | 13. islocal(kind(a(i;t)))
| | |   ⇒
| | |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| | |   ⇒
| | |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| | 14. ∀x:Id.
| | |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);...;1of())
| | |   ⇒
| | |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| | 15. ∀l@0:IdLnk.
| | |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(...)
| | |                                                        ,l@0>;1of(
| | |                                                              ))
| | |   ⇒
| | |   withlnk(l@0;m(i;t))
| | |   =
| | |   if source(l@0) = i→
| | |      concat(map(λtgf.map(λx.<1of(tgf)
| | |                          ,x>;2of(tgf)
| | |                              ((λx.s(i;t).x)
| | |                              ,val(a(i;t))));2of()
| | |                                            (<kind(a(i;t))
| | |                                             ,l@0>)))
| | |   else nil fi
| | 16. ∀x:Id.
| | |   ¬(deq-member(IdDeq;x;1of())
```

```
| | |     ⇒
| | |     deq-member(KindDeq;kind(a(i;t));2of()(x)))
| | |   ⇒
| | |   s(i;t).x = s(i;t+1).x
| | 17. ∀l@0:IdLnk, tg@0:Id.
| | |   ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| | |      (<l,tg>
| | |      ,<l@0,tg@0>) ∨2 false2)
| | |     ⇒
| | |     deq-member(KindDeq;kind(a(i;t));L))
| | |   ⇒
| | |   w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| | 18. (kind(a(i;t)) ∈ L)
| | ⊢  (kind(a(j;t)) ∈ L)
| | | by Subst (kind(a(j;t)) = kind(a(i;t))) 0 THEN Analyze
| | |
| | |\
| | | .....subterm .....
| | | 1. i : Id
| | | 2. L : Knd List
| | | 3. l : IdLnk
| | | 4. tg : Id
| | | 5. w : World
| | | 6. FairFifo
| | | 7. FairFifo
| | | 8. j : Id
| | | 9. t : ℕ
| | | 10. j = i
| | | 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| | | 12. ¬isnull(a(i;t))
| | | 13. islocal(kind(a(i;t)))
| | |     ⇒
| | |     deq-member(IdDeq;act(kind(a(i;t)));1of())
| | |     ⇒
| | |     2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| | | 14. ∀x:Id.
| | |     deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| | |                                                   ,x>;1of())
| | |     ⇒
| | |     s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| | | 15. ∀l@0:IdLnk.
| | |     deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| | |                                                                ))
| | |     ⇒
| | |     withlnk(l@0;m(i;t))
| | |     =
| | |     if source(l@0) = i→
| | |        concat(map(λtgf.map(λx.<1of(tgf)
| | |                             ,x>;2of(tgf)
| | |                                 ((λx.s(i;t).x)
| | |                                 ,val(a(i;t))));2of()
| | |                                               (<kind(a(i;t))
| | |                                                ,l@0>)))
| | |     else nil fi
| | | 16. ∀x:Id.
```

```
| | |     ¬(deq-member(IdDeq;x;1of())
| | |       ⇒
| | |       deq-member(KindDeq;kind(a(i;t));2of()(x)))
| | |     ⇒
| | |     s(i;t).x = s(i;t+1).x
| | | 17. ∀l@0:IdLnk, tg@0:Id.
| | |     ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| | |        (<l,tg>
| | |        ,<l@0,tg@0>) ∨2 false2)
| | |       ⇒
| | |       deq-member(KindDeq;kind(a(i;t));L))
| | |     ⇒
| | |     w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| | | 18. (kind(a(i;t)) ∈ L)
| | | ⊢  a(j;t) = a(i;t)  by Analyze
| | |
| | .\
| | . .....antecedent .....
| | . 1. i : Id
| | . 2. L : Knd List
| | . 3. l : IdLnk
| | . 4. tg : Id
| | . 5. w : World
| | . 6. FairFifo
| | . 7. FairFifo
| | . 8. j : Id
| | . 9. t : ℕ
| | . 10. j = i
| | . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| | . 12. ¬isnull(a(i;t))
| | . 13. islocal(kind(a(i;t)))
| | .     ⇒
| | .     deq-member(IdDeq;act(kind(a(i;t)));1of())
| | .     ⇒
| | .     2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| | . 14. ∀x:Id.
| | .     deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| | .                                                  ,x>;1of())
| | .     ⇒
| | .     s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| | . 15. ∀l@0:IdLnk.
| | .     deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| | .                                                            ))
| | .     ⇒
| | .     withlnk(l@0;m(i;t))
| | .     =
| | .     if source(l@0) = i→
| | .        concat(map(λtgf.map(λx.<1of(tgf)
| | .                              ,x>;2of(tgf)
| | .                                  ((λx.s(i;t).x)
| | .                                  ,val(a(i;t))));2of()
| | .                                                 (<kind(a(i;t))
| | .                                                  ,l@0>)))
| | .     else nil fi
| | . 16. ∀x:Id.
```

```
| | .     ¬(deq-member(IdDeq;x;1of())
| | .       ⇒
| | .       deq-member(KindDeq;kind(a(i;t));2of()(x)))
| | .     ⇒
| | .     s(i;t).x = s(i;t+1).x
| | . 17. ∀l@0:IdLnk, tg@0:Id.
| | .     ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| | .        (<l,tg>
| | .        ,<l@0,tg@0>) ∨_2 false_2)
| | .       ⇒
| | .       deq-member(KindDeq;kind(a(i;t));L))
| | .     ⇒
| | .     w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| | . 18. (kind(a(i;t)) ∈ L)
| | . ⊢  ¬isnull(a(j;t))  by WeakSubstFor j 0
| |
| .\
| . 1. i : Id
| . 2. L : Knd List
| . 3. l : IdLnk
| . 4. tg : Id
| . 5. w : World
| . 6. FairFifo
| . 7. FairFifo
| . 8. j : Id
| . 9. t : ℕ
| . 10. j = i
| . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . 12. ¬isnull(a(i;t))
| . 13. islocal(kind(a(i;t)))
| . |   ⇒
| . |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| . |   ⇒
| . |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . 14. ∀x:Id.
| . |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);...;1of())
| . |   ⇒
| . |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . 15. ∀l@0:IdLnk.
| . |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);<kind(...)
| . |                                                       ,l@0>;1of(
| . |                                                             ))

| . |   ⇒
| . |   withlnk(l@0;m(i;t))
| . |   =
| . |   if source(l@0) = i→
| . |      concat(map(λtgf.map(λx.<1of(tgf)
| . |                          ,x>;2of(tgf)
| . |                              ((λx.s(i;t).x)
| . |                              ,val(a(i;t))));2of()
| . |                                             (<kind(a(i;t))
| . |                                              ,l@0>)))
| . |   else nil fi
| . 16. ∀x:Id.
| . |   ¬(deq-member(IdDeq;x;1of())
```

```
| . |      ⇒
| . |      deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . |    ⇒
| . |    s(i;t).x = s(i;t+1).x
| . 17. ∀l@0:IdLnk, tg@0:Id.
| . |    ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . |       (<l,tg>
| . |       ,<l@0,tg@0>) ∨₂ false₂)
| . |      ⇒
| . |      deq-member(KindDeq;kind(a(i;t));L))
| . |    ⇒
| . |    w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . 18. ¬(kind(a(i;t)) ∈ L)
| . ⊢  (kind(<j,t>) ∈ L)  by InstHyp [l;tg] -2
| . |
| . |\
| . | .....antecedent .....
| . | 1. i : Id
| . | 2. L : Knd List
| . | 3. l : IdLnk
| . | 4. tg : Id
| . | 5. w : World
| . | 6. FairFifo
| . | 7. FairFifo
| . | 8. j : Id
| . | 9. t : ℕ
| . | 10. j = i
| . | 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . | 12. ¬isnull(a(i;t))
| . | 13. islocal(kind(a(i;t)))
| . |     ⇒
| . |     deq-member(IdDeq;act(kind(a(i;t)));1of())
| . |     ⇒
| . |     2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . | 14. ∀x:Id.
| . |     deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| . |                                                 ,x>;1of())
| . |     ⇒
| . |     s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . | 15. ∀l@0:IdLnk.
| . |     deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| . |                                                           ))
| . |     ⇒
| . |     withlnk(l@0;m(i;t))
| . |     =
| . |     if source(l@0) = i→
| . |        concat(map(λtgf.map(λx.<1of(tgf)
| . |                             ,x>;2of(tgf)
| . |                                 ((λx.s(i;t).x)
| . |                                 ,val(a(i;t))));2of()
| . |                                                (<kind(a(i;t))
| . |                                                 ,l@0>)))
| . |     else nil fi
| . | 16. ∀x:Id.
| . |     ¬(deq-member(IdDeq;x;1of())
```

```
| . |       ⇒
| . |       deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . |     ⇒
| . |     s(i;t).x = s(i;t+1).x
| . | 17. ∀l@0:IdLnk, tg@0:Id.
| . |     ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . |        (<l,tg>
| . |        ,<l@0,tg@0>) ∨2 false2)
| . |       ⇒
| . |       deq-member(KindDeq;kind(a(i;t));L))
| . |     ⇒
| . |     w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . | 18. ¬(kind(a(i;t)) ∈ L)
| . | ⊢  ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))(<l,tg>,<l,tg>)
| . |       ∨2 false2)
| . |      ⇒
| . |      deq-member(KindDeq;kind(a(i;t));L))
| . |   by RWO
| . |      Thm* ∀d:EqDecider(A), i:A. (eqof(d)(i,i)) ~ true2
| . |      {eqof_eq_btrue}
| . |      0
| . |      THEN
| . |      Reduce 0
| . |      THEN
| . |      Analyze 0
| . |      THEN
| . |      Analyze -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
| . |
| . .\
| . . 1. i : Id
| . . 2. L : Knd List
| . . 3. l : IdLnk
| . . 4. tg : Id
| . . 5. w : World
| . . 6. FairFifo
| . . 7. FairFifo
| . . 8. j : Id
| . . 9. t : ℕ
| . . 10. j = i
| . . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . 12. ¬isnull(a(i;t))
| . . 13. islocal(kind(a(i;t)))
| . . |   ⇒
| . . |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| . . |   ⇒
| . . |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . . 14. ∀x:Id.
| . . |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| . . |                                                ,x>;1of())
```

```
| . . |   ⇒
| . . |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . . 15. ∀l@0:IdLnk.
| . . |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| . . |                                                            ))
| . . |   ⇒
| . . |   withlnk(l@0;m(i;t))
| . . |   =
| . . |   if source(l@0) = i→
| . . |      concat(map(λtgf.map(λx.<1of(tgf)
| . . |                          ,x>;2of(tgf)
| . . |                              ((λx.s(i;t).x)
| . . |                              ,val(a(i;t))));2of()
| . . |                                             (<kind(a(i;t))
| . . |                                              ,l@0>)))
| . . |   else nil fi
| . . 16. ∀x:Id.
| . . |   ¬(deq-member(IdDeq;x;1of())
| . . |     ⇒
| . . |     deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . . |   ⇒
| . . |   s(i;t).x = s(i;t+1).x
| . . 17. ∀l@0:IdLnk, tg@0:Id.
| . . |   ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . . |      (<l,tg>
| . . |      ,<l@0,tg@0>) ∨2 false2)
| . . |     ⇒
| . . |     deq-member(KindDeq;kind(a(i;t));L))
| . . |   ⇒
| . . |   w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . . 18. ¬(kind(a(i;t)) ∈ L)
| . . 19. w-tagged(tg; onlnk(l;m(i;t))) = nil
| . . ⊢  (kind(<j,t>) ∈ L)
| . . | by Assert null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . |
| . . .....assertion .....
| . . 1. i : Id
| . . 2. L : Knd List
| . . 3. l : IdLnk
| . . 4. tg : Id
| . . 5. w : World
| . . 6. FairFifo
| . . 7. FairFifo
| . . 8. j : Id
| . . 9. t : ℕ
| . . 10. j = i
| . . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . 12. ¬isnull(a(i;t))
| . . 13. islocal(kind(a(i;t)))
| . . |   ⇒
| . . |   deq-member(IdDeq;act(kind(a(i;t)));1of())
| . . |   ⇒
| . . |   2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . . 14. ∀x:Id.
| . . |   deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
```

```
| . . |                                                ,x>;1of())
| . . |   ⇒
| . . |   s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . . 15. ∀l@0:IdLnk.
| . . |   deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| . . |                                                          ))
| . . |   ⇒
| . . |   withlnk(l@0;m(i;t))
| . . |   =
| . . |   if source(l@0) = i→
| . . |      concat(map(λtgf.map(λx.<1of(tgf)
| . . |                             ,x>;2of(tgf)
| . . |                                 ((λx.s(i;t).x)
| . . |                                 ,val(a(i;t))));2of()
| . . |                                                (<kind(a(i;t))
| . . |                                                 ,l@0>)))
| . . |   else nil fi
| . . 16. ∀x:Id.
| . . |   ¬(deq-member(IdDeq;x;1of())
| . . |     ⇒
| . . |     deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . . |   ⇒
| . . |   s(i;t).x = s(i;t+1).x
| . . 17. ∀l@0:IdLnk, tg@0:Id.
| . . |   ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . . |      (<l,tg>
| . . |      ,<l@0,tg@0>) ∨₂ false₂)
| . . |     ⇒
| . . |     deq-member(KindDeq;kind(a(i;t));L))
| . . |   ⇒
| . . |   w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . . 18. ¬(kind(a(i;t)) ∈ L)
| . . 19. w-tagged(tg; onlnk(l;m(i;t))) = nil
| . . ⊢  null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . | by Unfold ‘w-sends‘ 0 THEN Unfolds [‘w-loc‘;‘w-time‘] 0
| . . |    THEN
| . . |    Reduce 0
| . . |    THEN
| . . |    Unfold ‘w-tagged‘ -1
| . . |
| . . 1. i : Id
| . . 2. L : Knd List
| . . 3. l : IdLnk
| . . 4. tg : Id
| . . 5. w : World
| . . 6. FairFifo
| . . 7. FairFifo
| . . 8. j : Id
| . . 9. t : ℕ
| . . 10. j = i
| . . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . 12. ¬isnull(a(i;t))
| . . 13. islocal(kind(a(i;t)))
| . . |   ⇒
| . . |   deq-member(IdDeq;act(kind(a(i;t)));1of())
```

```
| . . |    ⇒
| . . |    2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . . 14. ∀x:Id.
| . . |    deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| . . |                                                  ,x>;1of())
| . . |    ⇒
| . . |    s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . . 15. ∀l@0:IdLnk.
| . . |    deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| . . |                                                           ))
| . . |    ⇒
| . . |    withlnk(l@0;m(i;t))
| . . |    =
| . . |    if source(l@0) = i→
| . . |       concat(map(λtgf.map(λx.<1of(tgf)
| . . |                            ,x>;2of(tgf)
| . . |                                ((λx.s(i;t).x)
| . . |                                ,val(a(i;t))));2of()
| . . |                                               (<kind(a(i;t))
| . . |                                                ,l@0>)))
| . . |    else nil fi
| . . 16. ∀x:Id.
| . . |    ¬(deq-member(IdDeq;x;1of())
| . . |      ⇒
| . . |      deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . . |    ⇒
| . . |    s(i;t).x = s(i;t+1).x
| . . 17. ∀l@0:IdLnk, tg@0:Id.
| . . |    ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . . |       (<l,tg>
| . . |       ,<l@0,tg@0>) ∨2 false2)
| . . |      ⇒
| . . |      deq-member(KindDeq;kind(a(i;t));L))
| . . |    ⇒
| . . |    w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . . 18. ¬(kind(a(i;t)) ∈ L)
| . . 19. filter(λms.mtag(ms) = tg;onlnk(l;m(i;t))) = nil
| . . ⊢  null(filter(λm.mtag(m) = tg;onlnk(l;m(j;t))))
| . . | by WeakSubstFor j 0
| . . |
| . . 1. i : Id
| . . 2. L : Knd List
| . . 3. l : IdLnk
| . . 4. tg : Id
| . . 5. w : World
| . . 6. FairFifo
| . . 7. FairFifo
| . . 8. j : Id
| . . 9. t : ℕ
| . . 10. j = i
| . . 11. ¬null(filter(λm.mtag(m) = tg;sends(l;<j,t>)))
| . . 12. ¬isnull(a(i;t))
| . . 13. islocal(kind(a(i;t)))
| . .      ⇒
| . .      deq-member(IdDeq;act(kind(a(i;t)));1of())
```

```
| . .     ⇒
| . .     2of()(act(kind(a(i;t))),λx.s(i;t).x,val(a(i;t)))
| . . 14. ∀x:Id.
| . .     deq-member(product-deq(Knd;Id;KindDeq;IdDeq);<kind(a(i;t))
| . .                                                  ,x>;1of())
| . .     ⇒
| . .     s(i;t+1).x = 2of()(<kind(a(i;t)),x>,λx.s(i;t).x,val(a(i;t)))
| . . 15. ∀l@0:IdLnk.
| . .     deq-member(product-deq(Knd;IdLnk;KindDeq;IdLnkDeq);...;1of(
| . .                                                            ))
| . .     ⇒
| . .     withlnk(l@0;m(i;t))
| . .     =
| . .     if source(l@0) = i→
| . .        concat(map(λtgf.map(λx.<1of(tgf)
| . .                              ,x>;2of(tgf)
| . .                                  ((λx.s(i;t).x)
| . .                                  ,val(a(i;t))));2of()
| . .                                                 (<kind(a(i;t))
| . .                                                  ,l@0>)))
| . .     else nil fi
| . . 16. ∀x:Id.
| . .     ¬(deq-member(IdDeq;x;1of())
| . .       ⇒
| . .       deq-member(KindDeq;kind(a(i;t));2of()(x)))
| . .     ⇒
| . .     s(i;t).x = s(i;t+1).x
| . . 17. ∀l@0:IdLnk, tg@0:Id.
| . .     ¬((eqof(product-deq(IdLnk;Id;IdLnkDeq;IdDeq))
| . .        (<l,tg>
| . .        ,<l@0,tg@0>) ∨2 false2)
| . .       ⇒
| . .       deq-member(KindDeq;kind(a(i;t));L))
| . .     ⇒
| . .     w-tagged(tg@0; onlnk(l@0;m(i;t))) = nil
| . . 18. ¬(kind(a(i;t)) ∈ L)
| . . 19. filter(λms.mtag(ms) = tg;onlnk(l;m(i;t))) = nil
| . . ⊢  null(filter(λm.mtag(m) = tg;onlnk(l;m(i;t))))
| . .   by (HypSubst -1 0) THEN (Reduce 0)
|
.\
. 1. i : Id
. 2. L : Knd List
. 3. l : IdLnk
. 4. tg : Id
. 5. w : World
. 6. FairFifo
. 7. FairFifo
. 8. ∀i@0,x:Id.
.    vartype(i@0;x) ⊆r if deq-member(IdDeq;x;1of(1of(if eqof(IdDeq)
.                                                      (i@0
.                                                      ,i)→
.                                                      <
.                                                      ,
.                                                      ,
```

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

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

.                   else  fi.pre(a,λx.s(i@0;t').x)
. 14. e : E
. 15. loc(e) = i
. 16. m : Msg
. ⊢  mtag(m) ∈ Id  by Auto THEN Unfold `w-Msg` -1
END
```