```
w-es_wf  THM

⊢  ∀w:World, p:FairFifo. ES(w) ∈ ES
| by Auto
|    THEN
|    Assert
|    (∀e:E.
|     V(loc(e);kind(e))
|     =
|     eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e))
|
|\
| .....assertion .....
| 1. w : World
| 2. FairFifo
| ⊢  ∀e:E.
|    V(loc(e);kind(e))
|    =
|    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
|   by Auto
|      THEN
|      Subst
|      (eventtype(λe.kind(e);λe.loc(e);λi,a.
|       V(i;locl(a));w.M;e) ~ V(loc(e);kind(e)))
|      0
|      THENL
|      [Unfolds [`w-V`;`w-M`;`eventtype`] 0 THEN Reduce 0 THEN Trivial
|      ;Auto]
|
.\
. 1. w : World
. 2. p : FairFifo
. 3. ∀e:E.
. |  V(loc(e);kind(e))
. |  =
. |  eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. ⊢  ES(w) ∈ ES
. | by Assert
. |    (ESAxioms{i:l}
. |             (E;
. |              (λi,x. vartype(i;x));
. |              w.M;
. |              (λe.loc(e));
. |              (λe.kind(e));
. |              (λe.val(e));
. |              (λx,e. (x when e));
. |              (λx,e. (x after e));
. |              (λl,e. sends(l;e));
. |              (λe.sender(e));
. |              (λe.index(e));
. |              (λe.first(e));
. |              (λe.pred(e));
. |              (λe,e'. e <c e'))
. |     ∈ Type)
. |
```

```
. |\
. | .....assertion .....
. | 1. w : World
. | 2. FairFifo
. | 3. ∀e:E.
. |    V(loc(e);kind(e))
. |    =
. |    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. | ⊢  ESAxioms{i:l}
. |            (E;
. |             (λi,x. vartype(i;x));
. |             w.M;
. |             (λe.loc(e));
. |             (λe.kind(e));
. |             (λe.val(e));
. |             (λx,e. (x when e));
. |             (λx,e. (x after e));
. |             (λl,e. sends(l;e));
. |             (λe.sender(e));
. |             (λe.index(e));
. |             (λe.first(e));
. |             (λe.pred(e));
. |             (λe,e'. e <c e'))
. |    ∈ Type
. |   by let A
. |          ≡ Auto
. |            THEN
. |            Try (Analyze -1 THEN Unhide THEN Complete Auto)
. |            THEN
. |            Try (Analyze -2 THEN Unhide THEN Complete Auto)
. |            THEN
. |            Try (Unfold `w-E` 0 THEN DeqSubtype)
. |            THEN
. |            Try
. |            (DoSubsume THEN SubtypeRelEq THEN BackThruSomeHyp) ,
. |          B
. |          ≡ Analyze
. |            THENL
. |            [Analyze
. |             THENL
. |             [BackThru
. |              Thm* ∀the_w:World, l:IdLnk, e:E.
. |                   sends(l;e) ∈ Msg_sub(l; the_w.M) List
. |              {better_DASH_w_DASH_sends_DASH_wf}
. |             ;Auto]
. |            ;Auto] in
. |      Using [`V',(λi,a. V(i;locl(a)))] Analyze THEN Reduce 0
. |      THEN
. |      Try (Complete A)
. |      THEN
. |      Try (Complete B)
. |
. .\
. . 1. w : World
. . 2. p : FairFifo
```

```
. . 3. ∀e:E.
. . |  V(loc(e);kind(e))
. . |  =
. . |  eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . 4. ESAxioms{i:l}
. . |          (E;
. . |           (λi,x. vartype(i;x));
. . |           w.M;
. . |           (λe.loc(e));
. . |           (λe.kind(e));
. . |           (λe.val(e));
. . |           (λx,e. (x when e));
. . |           (λx,e. (x after e));
. . |           (λl,e. sends(l;e));
. . |           (λe.sender(e));
. . |           (λe.index(e));
. . |           (λe.first(e));
. . |           (λe.pred(e));
. . |           (λe,e'. e <c e'))
. . |  ∈ Type
. . ⊢  ES(w) ∈ ES
. . | by let A
. . |        ≡ Auto
. . |          THEN
. . |          Try (Analyze -1 THEN Unhide THEN Complete Auto)
. . |          THEN
. . |          Try (Analyze -2 THEN Unhide THEN Complete Auto)
. . |          THEN
. . |          Try (Unfold `w-E` 0 THEN DeqSubtype)
. . |          THEN
. . |          Try
. . |          (DoSubsume THEN SubtypeRelEq THEN BackThruSomeHyp) ,
. . |        B
. . |        ≡ Analyze
. . |          THENL
. . |          [Analyze
. . |           THENL
. . |           [BackThru
. . |            Thm* ∀the_w:World, l:IdLnk, e:E.
. . |                 sends(l;e) ∈ Msg_sub(l; the_w.M) List
. . |            {better_DASH_w_DASH_sends_DASH_wf}
. . |           ;Auto]
. . |          ;Auto] in
. . |    Unfold `w-es` 0 THEN Fold `mk-es` 0 THEN At Type Analyze
. . |    THEN
. . |    All Reduce
. . |    THEN
. . |    Try (Complete A)
. . |    THEN
. . |    Try (Complete B)
. . |
. . 1. w : World
. . 2. p : FairFifo
. . 3. ∀e:E.
. . |  V(loc(e);kind(e))
```

```
. . |  =
. . |  eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . 4. ESAxioms{i:l}
. . |          (E;
. . |           (λi,x. vartype(i;x));
. . |           w.M;
. . |           (λe.loc(e));
. . |           (λe.kind(e));
. . |           (λe.val(e));
. . |           (λx,e. (x when e));
. . |           (λx,e. (x after e));
. . |           (λl,e. sends(l;e));
. . |           (λe.sender(e));
. . |           (λe.index(e));
. . |           (λe.first(e));
. . |           (λe.pred(e));
. . |           (λe,e'. e <c e'))
. . |  ∈ Type
. . ⊢  world_DASH_event_DASH_system{1:l, i:l}(w,p)
. . |  ∈ ESAxioms{i:l}
. . |            (E;
. . |             (λi,x. vartype(i;x));
. . |             w.M;
. . |             (λe.loc(e));
. . |             (λe.kind(e));
. . |             (λe.val(e));
. . |             (λx,e. (x when e));
. . |             (λx,e. (x after e));
. . |             (λl,e. sends(l;e));
. . |             (λe.sender(e));
. . |             (λe.index(e));
. . |             (λe.first(e));
. . |             (λe.pred(e));
. . |             (λe,e'. e <c e'))  by At Type Analyze
. . |
. . |\
. . | .....subterm .....

. . | 1. w : World
. . | 2. FairFifo
. . | 3. ∀e:E.
. . | |  V(loc(e);kind(e))
. . | |  =
. . | |  eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . | 4. ESAxioms{i:l}
. . | |          (E;
. . | |           (λi,x. vartype(i;x));
. . | |           w.M;
. . | |           (λe.loc(e));
. . | |           (λe.kind(e));
. . | |           (λe.val(e));
. . | |           (λx,e. (x when e));
. . | |           (λx,e. (x after e));
. . | |           (λl,e. sends(l;e));
. . | |           (λe.sender(e));
. . | |           (λe.index(e));
```

```
. . | |           (λe.first(e));
. . | |           (λe.pred(e));
. . | |           (λe,e'. e <c e'))
. . | |  ∈ Type
. . | ⊢  world_DASH_event_DASH_system{1:l, i:l}(w)
. . | |  ∈ FairFifo→ESAxioms{i:l}
. . | |                      (E;
. . | |                       (λi,x. vartype(i;x));
. . | |                       w.M;
. . | |                       (λe.loc(e));
. . | |                       (λe.kind(e));
. . | |                       (λe.val(e));
. . | |                       (λx,e. (x when e));
. . | |                       (λx,e. (x after e));
. . | |                       (λl,e. sends(l;e));
. . | |                       (λe.sender(e));
. . | |                       (λe.index(e));
. . | |                       (λe.first(e));
. . | |                       (λe.pred(e));
. . | |                       (λe,e'. e <c e'))  by At Type Analyze
. . | |
. . | |\
. . | | .....subterm .....
. . | | 1. w : World
. . | | 2. FairFifo
. . | | 3. ∀e:E.
. . | |    V(loc(e);kind(e))
. . | |    =
. . | |    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . | | 4. ESAxioms{i:l}
. . | |           (E;
. . | |            (λi,x. vartype(i;x));
. . | |            w.M;
. . | |            (λe.loc(e));
. . | |            (λe.kind(e));
. . | |            (λe.val(e));
. . | |            (λx,e. (x when e));
. . | |            (λx,e. (x after e));
. . | |            (λl,e. sends(l;e));
. . | |            (λe.sender(e));
. . | |            (λe.index(e));
. . | |            (λe.first(e));
. . | |            (λe.pred(e));
. . | |            (λe,e'. e <c e'))
. . | |    ∈ Type
. . | | ⊢  world_DASH_event_DASH_system{1:l, i:l}
. . | |    ∈ the_w:World→FairFifo
. . | |                 ⇒
. . | |      ESAxioms{i:l}
. . | |             (E;
. . | |              (λi,x. vartype(i;x));
. . | |              the_w.M;
. . | |              (λe.loc(e));
. . | |              (λe.kind(e));
. . | |              (λe.val(e));
```

```
. . | |                (λx,e. (x when e));
. . | |                (λx,e. (x after e));
. . | |                (λl,e. sends(l;e));
. . | |                (λe.sender(e));
. . | |                (λe.index(e));
. . | |                (λe.first(e));
. . | |                (λe.pred(e));
. . | |                (λe,e'. e <c e'))  by Fold `all` 0
. . | |
. . | |\
. . | | .....subterm .....
. . | | 1. w : World
. . | | 2. FairFifo
. . | | 3. ∀e:E.
. . | |    V(loc(e);kind(e))
. . | |    =
. . | |    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . | | 4. ESAxioms{i:l}
. . | |            (E;
. . | |             (λi,x. vartype(i;x));
. . | |             w.M;
. . | |             (λe.loc(e));
. . | |             (λe.kind(e));
. . | |             (λe.val(e));
. . | |             (λx,e. (x when e));
. . | |             (λx,e. (x after e));
. . | |             (λl,e. sends(l;e));
. . | |             (λe.sender(e));
. . | |             (λe.index(e));
. . | |             (λe.first(e));
. . | |             (λe.pred(e));
. . | |             (λe,e'. e <c e'))
. . | |    ∈ Type
. . | | ⊢  w ∈ World  by Auto
. . | |
. . | .\
. . | . .....eq aux .....
. . | . 1. w : World
. . | . 2. FairFifo
. . | . 3. ∀e:E.
. . | .    V(loc(e);kind(e))
. . | .    =
. . | .    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . | . 4. ESAxioms{i:l}
. . | .            (E;
. . | .             (λi,x. vartype(i;x));
. . | .             w.M;
. . | .             (λe.loc(e));
. . | .             (λe.kind(e));
. . | .             (λe.val(e));
. . | .             (λx,e. (x when e));
. . | .             (λx,e. (x after e));
. . | .             (λl,e. sends(l;e));
. . | .             (λe.sender(e));
. . | .             (λe.index(e));
```

```
. . | .             (λe.first(e));
. . | .             (λe.pred(e));
. . | .             (λe,e'. e <c e'))
. . | .    ∈ Type
. . | . 5. world_DASH_event_DASH_system{1:l, i:l}(w)
. . | .    =
. . | .    world_DASH_event_DASH_system{1:l, i:l}(w)
. . | . ⊢  (FairFifo
. . | .     ⇒
. . | .     ESAxioms{i:l}
. . | .             (E;
. . | .              (λi,x. vartype(i;x));
. . | .              w.M;
. . | .              (λe.loc(e));
. . | .              (λe.kind(e));
. . | .              (λe.val(e));
. . | .              (λx,e. (x when e));
. . | .              (λx,e. (x after e));
. . | .              (λl,e. sends(l;e));
. . | .              (λe.sender(e));
. . | .              (λe.index(e));
. . | .              (λe.first(e));
. . | .              (λe.pred(e));
. . | .              (λe,e'. e <c e')))
. . | .    ∈ Type  by Auto
. . |
. . .\
. . . .....subterm .....
. . . 1. w : World
. . . 2. p : FairFifo
. . . 3. ∀e:E.
. . .    V(loc(e);kind(e))
. . .    =
. . .    eventtype(λe.kind(e);λe.loc(e);λi,a. V(i;locl(a));w.M;e)
. . . 4. ESAxioms{i:l}
. . .           (E;
. . .            (λi,x. vartype(i;x));
. . .            w.M;
. . .            (λe.loc(e));
. . .            (λe.kind(e));
. . .            (λe.val(e));
. . .            (λx,e. (x when e));
. . .            (λx,e. (x after e));
. . .            (λl,e. sends(l;e));
. . .            (λe.sender(e));
. . .            (λe.index(e));
. . .            (λe.first(e));
. . .            (λe.pred(e));
. . .            (λe,e'. e <c e'))
. . .    ∈ Type
. . . ⊢  p ∈ FairFifo  by Auto
END
```