```
covers_pred_lemma2  THM

⊢  ∀r:rel(), I:Fmla, A:ioa{i:l}(), a:Label.
|  covers_pred(A;I) ⇒
|  r ∈ I ⇒
|  (∃r':rel().
|   r' ∈ col_subst2(λx.smts_eff(action_effect(a;A.eff;A.frame);x);r))
| by Unfolds ``covers_pred pred`` 0

|    THEN Unfold `pred_mentions` 0 THEN UnivCD THENA Auto
|
1. r : rel()
2. I : Collection(rel())
3. A : ioa{i:l}()
4. a : Label
5. ∀x:Label. (∃r:rel(). r ∈ I & rel_mentions(r;x)) ⇒ covers_var(A;x)
6. r ∈ I
⊢  ∃r':rel().
|  r' ∈ col_subst2(λx.smts_eff(action_effect(a;A.eff;A.frame);x);r)
| by Assert ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
|
|\
| .....assertion .....
| 1. r : rel()
| 2. I : Collection(rel())
| 3. A : ioa{i:l}()
| 4. Label
| 5. ∀x:Label.
|    (∃r:rel(). r ∈ I & rel_mentions(r;x)) ⇒ covers_var(A;x)
| 6. r ∈ I
| ⊢  ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
|   by Auto THEN BackThruSomeHyp THEN AutoInstConcl [] THEN Auto
|
.\
. 1. r : rel()
. 2. I : Collection(rel())
. 3. A : ioa{i:l}()
. 4. a : Label
. 5. ∀x:Label.
. |  (∃r:rel(). r ∈ I & rel_mentions(r;x)) ⇒ covers_var(A;x)
. 6. r ∈ I
. 7. ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
. ⊢  ∃r':rel().
. |  r' ∈ col_subst2(λx.smts_eff(action_effect(a;A.eff;A.frame);x);r)
. | by Thin (-3)
. |
. 1. r : rel()
. 2. I : Collection(rel())
. 3. A : ioa{i:l}()
. 4. a : Label
. 5. r ∈ I
. 6. ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
. ⊢  ∃r':rel().
. |  r' ∈ col_subst2(λx.smts_eff(action_effect(a;A.eff;A.frame);x);r)
. | by ...
```

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. |
. 1. r : rel()
. 2. I : Collection(rel())
. 3. A : ioa{i:l}()
. 4. a : Label
. 5. r ∈ I
. 6. ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
. ⊢  ∃r':rel(), as:(Label×Term) List.
. |  1of(unzip(as)) = rel_primed_vars(r)
. |  & (∀i:ℕ.
. |     i<||as|| ⇒
. |     2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
. |                  (1of(as[i])))
. |  & r' = rel_subst2(as;r)
. | by Assert ∃as:(Label×Term) List.
. |    1of(unzip(as)) = rel_primed_vars(r)
. |    & (∀i:ℕ.
. |       i<||as|| ⇒
. |       2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);...))
. |
. |\
. | .....assertion .....
. | 1. r : rel()
. | 2. I : Collection(rel())
. | 3. A : ioa{i:l}()
. | 4. a : Label
. | 5. r ∈ I
. | 6. ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
. | ⊢  ∃as:(Label×Term) List.
. | |  1of(unzip(as)) = rel_primed_vars(r)
. | |  & (∀i:ℕ.
. | |     i<||as|| ⇒
. | |     2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);...))
. | | by RWW "rel_mentions_iff" (-1) THENA Auto
. | |
. | 1. r : rel()
. | 2. I : Collection(rel())
. | 3. A : ioa{i:l}()
. | 4. a : Label
. | 5. r ∈ I
. | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | ⊢  ∃as:(Label×Term) List.
. | |  1of(unzip(as)) = rel_primed_vars(r)
. | |  & (∀i:ℕ.
. | |     i<||as|| ⇒
. | |     2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);...))
. | | by Assert ∀x:Label.
. | |    ∃t:Term.
. | |    (x ∈ rel_primed_vars(r)) ⇒
. | |    t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | |
. | |\
. | | .....assertion .....
. | | 1. r : rel()
. | | 2. I : Collection(rel())
```

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. | | 3. A : ioa{i:l}()
. | | 4. a : Label
. | | 5. r ∈ I
. | | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | ⊢  ∀x:Label.
. | | |  ∃t:Term.
. | | |  (x ∈ rel_primed_vars(r)) ⇒
. | | |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | | | by D 0 THENA Auto THEN
. | | Assert (x ∈ rel_primed_vars(r))
. | | |    ∨ ¬(x ∈ rel_primed_vars(r))
. | | |
. | | |\
. | | | .....assertion .....
. | | | 1. r : rel()
. | | | 2. I : Collection(rel())
. | | | 3. A : ioa{i:l}()
. | | | 4. Label
. | | | 5. r ∈ I
. | | | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | | 7. x : Label
. | | | ⊢  (x ∈ rel_primed_vars(r)) ∨ ¬(x ∈ rel_primed_vars(r))
. | | |   by Decide x ∈ rel_primed_vars(r) THENA Auto
. | | |
. | | |      THEN RWW "assert_lbls_member" (-1) THENA Auto
. | | |
. | | |      THENL [Sel 1 (D 0); Sel 2 (D 0)] THEN Auto•
. | | |
. | | .\
. | | . 1. r : rel()
. | | . 2. I : Collection(rel())
. | | . 3. A : ioa{i:l}()
. | | . 4. a : Label
. | | . 5. r ∈ I
. | | . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . 7. x : Label
. | | . 8. (x ∈ rel_primed_vars(r)) ∨ ¬(x ∈ rel_primed_vars(r))
. | | . ⊢  ∃t:Term.
. | | . |  (x ∈ rel_primed_vars(r)) ⇒
. | | . |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)  by D (-1)
. | | . |
. | | . |\
. | | . | 1. r : rel()
. | | . | 2. I : Collection(rel())
. | | . | 3. A : ioa{i:l}()
. | | . | 4. a : Label
. | | . | 5. r ∈ I
. | | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | 7. x : Label
. | | . | 8. (x ∈ rel_primed_vars(r))
. | | . | ⊢  ∃t:Term.
. | | . | |  (x ∈ rel_primed_vars(r)) ⇒
. | | . | |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | | . | | by Assert covers_var(A;x)
. | | . | |     THENL [SmAuto; Unfold ‘covers_var‘ (-1) THEN ExRepD]
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. | | . | |
. | | . | |\
. | | . | | .....assertion .....
. | | . | | 1. r : rel()
. | | . | | 2. I : Collection(rel())
. | | . | | 3. A : ioa{i:l}()
. | | . | | 4. Label
. | | . | | 5. r ∈ I
. | | . | | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | | 7. x : Label
. | | . | | 8. (x ∈ rel_primed_vars(r))
. | | . | | ⊢  covers_var(A;x)  by BackThruSomeHyp THEN Auto
. | | . | | |
. | | . | | 1. r : rel()
. | | . | | 2. I : Collection(rel())
. | | . | | 3. A : ioa{i:l}()
. | | . | | 4. Label
. | | . | | 5. r ∈ I
. | | . | | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | | 7. x : Label
. | | . | | 8. (x ∈ rel_primed_vars(r))
. | | . | | ⊢  (x ∈ rel_vars(r))
. | | . | |   by BackThruLemma ‘rel_primed_vars_rel_vars‘ THEN Auto
. | | . | |
. | | . | .\
. | | . | . 1. r : rel()
. | | . | . 2. I : Collection(rel())
. | | . | . 3. A : ioa{i:l}()
. | | . | . 4. a : Label
. | | . | . 5. r ∈ I
. | | . | . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . 7. x : Label
. | | . | . 8. (x ∈ rel_primed_vars(r))
. | | . | . 9. fr : frame()
. | | . | . 10. fr ∈ <fr ∈ A.frame | fr.var =1 x>
. | | . | . 11. ∀a:Label.
. | | . | . |   (a ∈ fr.acts) ⇒
. | | . | . |   (∃ef:eff().
. | | . | . |    ef ∈ <ef ∈ A.eff | ef.kind =1 a & ef.smt.lbl =1 x>)
. | | . | . ⊢  ∃t:Term.
. | | . | . |  (x ∈ rel_primed_vars(r)) ⇒
. | | . | . |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | | . | . | by Unfolds ‘‘smts_eff‘‘ 0 THEN Unfold ‘smt_terms‘ 0
. | | . | .

. | | . | . |    THEN All (RW ColMemberC)
. | | . | . THEN RepD
. | | . | . |
. | | . | . |
. | | . | . 1. r : rel()
. | | . | . 2. I : Collection(rel())
. | | . | . 3. A : ioa{i:l}()
. | | . | . 4. a : Label
. | | . | . 5. r ∈ I
. | | . | . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . 7. x : Label
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. | | . | . 8. (x ∈ rel_primed_vars(r))
. | | . | . 9. fr : frame()
. | | . | . 10. fr ∈ A.frame
. | | . | . 11. fr.var =1 x
. | | . | . 12. ∀a:Label.
. | | . | . |   (a ∈ fr.acts) ⇒
. | | . | . |   (∃ef:eff().
. | | . | . |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . ⊢  ∃t:Term.
. | | . | . |  (x ∈ rel_primed_vars(r)) ⇒
. | | . | . |  (∃s:smt().
. | | . | . |   s ∈ action_effect(a;A.eff;A.frame) & s.lbl =1 x
. | | . | . |   & t = s.term)
. | | . | . | by Assert ∃s:smt().
. | | . | . |    s ∈ <s ∈ action_effect(a;A.eff;A.frame) | s.lbl =1 x>
```

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. | | . | . |
. | | . | . |
. | | . | . |\
. | | . | . | .....assertion .....
. | | . | . | 1. r : rel()
. | | . | . | 2. I : Collection(rel())
. | | . | . | 3. A : ioa{i:l}()
. | | . | . | 4. a : Label
. | | . | . | 5. r ∈ I
. | | . | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | 7. x : Label
. | | . | . | 8. (x ∈ rel_primed_vars(r))
. | | . | . | 9. fr : frame()
. | | . | . | 10. fr ∈ A.frame
. | | . | . | 11. fr.var =1 x
. | | . | . | 12. ∀a:Label.
. | | . | . | |   (a ∈ fr.acts) ⇒
. | | . | . | |   (∃ef:eff().
. | | . | . | |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | ⊢  ∃s:smt().
. | | . | . | |  s ∈ <s ∈ action_effect(a;A.eff;A.frame) | s.lbl =1 x>
. | | . | . | | by Assert (a ∈ fr.acts) ∨ ¬(a ∈ fr.acts)
. | | . | . | |
. | | . | . | |\
. | | . | . | | .....assertion .....
. | | . | . | | 1. r : rel()
. | | . | . | | 2. I : Collection(rel())
. | | . | . | | 3. A : ioa{i:l}()
. | | . | . | | 4. a : Label
. | | . | . | | 5. r ∈ I
. | | . | . | | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | | 7. x : Label
. | | . | . | | 8. (x ∈ rel_primed_vars(r))
. | | . | . | | 9. fr : frame()
. | | . | . | | 10. fr ∈ A.frame
. | | . | . | | 11. fr.var =1 x
. | | . | . | | 12. ∀a:Label.
. | | . | . | |     (a ∈ fr.acts) ⇒
. | | . | . | |     (∃ef:eff().
. | | . | . | |      ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
```

```
. | | . | . | | ⊢  (a ∈ fr.acts) ∨ ¬(a ∈ fr.acts)
. | | . | . | |   by Decide a ∈ fr.acts THENA Auto
. | | . | . | |
. | | . | . | |      THEN RWW "assert_lbls_member" (-1) THENA Auto
. | | . | . | |
. | | . | . | |      THENL [Sel 1 (D 0); Sel 2 (D 0)] THEN Auto
. | | . | . | |
. | | . | . |.\
. | | . | . | . 1. r : rel()
. | | . | . | . 2. I : Collection(rel())
. | | . | . | . 3. A : ioa{i:l}()
. | | . | . | . 4. a : Label
. | | . | . | . 5. r ∈ I
. | | . | . | . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . 7. x : Label
. | | . | . | . 8. (x ∈ rel_primed_vars(r))
. | | . | . | . 9. fr : frame()
. | | . | . | . 10. fr ∈ A.frame
. | | . | . | . 11. fr.var =1 x
. | | . | . | . 12. ∀a:Label.
. | | . | . | . |   (a ∈ fr.acts) ⇒
. | | . | . | . |   (∃ef:eff().
. | | . | . | . |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . 13. (a ∈ fr.acts) ∨ ¬(a ∈ fr.acts)
. | | . | . | . ⊢  ∃s:smt().
. | | . | . | . |  s ∈ <s ∈ action_effect(a;A.eff;A.frame) |
. | | . | . | . |       s.lbl =1 x>  by D (-1)
. | | . | . | . |
. | | . | . | .|\
. | | . | . | . | 1. r : rel()
. | | . | . | . | 2. I : Collection(rel())
. | | . | . | . | 3. A : ioa{i:l}()
. | | . | . | . | 4. a : Label
. | | . | . | . | 5. r ∈ I
. | | . | . | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . | 7. x : Label
. | | . | . | . | 8. (x ∈ rel_primed_vars(r))
. | | . | . | . | 9. fr : frame()
. | | . | . | . | 10. fr ∈ A.frame
. | | . | . | . | 11. fr.var =1 x
. | | . | . | . | 12. ∀a:Label.
. | | . | . | . | |   (a ∈ fr.acts) ⇒
. | | . | . | . | |   (∃ef:eff().
. | | . | . | . | |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . | 13. (a ∈ fr.acts)
. | | . | . | . | ⊢  ∃s:smt().
. | | . | . | . | |  s ∈ <s ∈ action_effect(a;A.eff;A.frame) |
. | | . | . | . | |       s.lbl =1 x>
. | | . | . | . | | by InstHyp [a] (-2) THENA Auto THEN ExRepD
. | | . | . | . | |
. | | . | . | . | 1. r : rel()
. | | . | . | . | 2. I : Collection(rel())
. | | . | . | . | 3. A : ioa{i:l}()
. | | . | . | . | 4. a : Label
. | | . | . | . | 5. r ∈ I
```

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. | | . | . | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . | 7. x : Label
. | | . | . | . | 8. (x ∈ rel_primed_vars(r))
. | | . | . | . | 9. fr : frame()
. | | . | . | . | 10. fr ∈ A.frame
. | | . | . | . | 11. fr.var =1 x
. | | . | . | . | 12. ∀a:Label.
. | | . | . | . | |   (a ∈ fr.acts) ⇒
. | | . | . | . | |   (∃ef:eff().
. | | . | . | . | |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . | 13. (a ∈ fr.acts)
. | | . | . | . | 14. ef : eff()
. | | . | . | . | 15. ef ∈ A.eff
. | | . | . | . | 16. ef.kind =1 a
. | | . | . | . | 17. ef.smt.lbl =1 x
. | | . | . | . | ⊢  ∃s:smt().
. | | . | . | . | |  s ∈ <s ∈ action_effect(a;A.eff;A.frame) |
. | | . | . | . | |       s.lbl =1 x>
. | | . | . | . | | by InstConcl [ef.smt] THENA Auto
. | | . | . | . |
. | | . | . | . | |    THEN Unfold ‘action_effect‘ 0
. | | . | . | . |
. | | . | . | . | |    THEN All (RW ColMemberC)
. | | . | . | . |
. | | . | . | . | |    THEN All (RW assert_pushdownC)
. | | . | . | . | THEN Auto
. | | . | . | . | |
. | | . | . | . | 1. r : rel()
. | | . | . | . | 2. I : Collection(rel())
. | | . | . | . | 3. A : ioa{i:l}()
. | | . | . | . | 4. a : Label
. | | . | . | . | 5. r ∈ I
. | | . | . | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . | 7. x : Label
. | | . | . | . | 8. (x ∈ rel_primed_vars(r))
. | | . | . | . | 9. fr : frame()
. | | . | . | . | 10. fr ∈ A.frame
. | | . | . | . | 11. fr.var =1 x
. | | . | . | . | 12. ∀a:Label.
. | | . | . | . |     (a ∈ fr.acts) ⇒
. | | . | . | . |     (∃ef:eff().
. | | . | . | . |      ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . | 13. (a ∈ fr.acts)
. | | . | . | . | 14. ef : eff()
. | | . | . | . | 15. ef ∈ A.eff
. | | . | . | . | 16. ef.kind =1 a
. | | . | . | . | 17. ef.smt.lbl =1 x
. | | . | . | . | ⊢  (∃e:eff().
. | | . | . | . |     e ∈ A.eff & e.kind =1 a & ef.smt = e.smt)
. | | . | . | . |    ∨ (∃f:frame().
. | | . | . | . |       f ∈ A.frame & ¬a ∈ f.acts
. | | . | . | . |       & ef.smt = mk_smt(f.var, f.var, f.typ))
. | | . | . | . |   by Sel 1 (D 0) THENA Auto
. | | . | . | . |
. | | . | . | . |     THEN AutoInstConcl [] THEN Auto
```

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. | | . | . | . |
. | | . | . | . .\
. | | . | . | . . 1. r : rel()
. | | . | . | . . 2. I : Collection(rel())
. | | . | . | . . 3. A : ioa{i:l}()
. | | . | . | . . 4. a : Label
. | | . | . | . . 5. r ∈ I
. | | . | . | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . . 7. x : Label
. | | . | . | . . 8. (x ∈ rel_primed_vars(r))
. | | . | . | . . 9. fr : frame()
. | | . | . | . . 10. fr ∈ A.frame
. | | . | . | . . 11. fr.var =1 x
. | | . | . | . . 12. ∀a:Label.
. | | . | . | . . |   (a ∈ fr.acts) ⇒
. | | . | . | . . |   (∃ef:eff().
. | | . | . | . . |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . . 13. ¬(a ∈ fr.acts)
. | | . | . | . . ⊢  ∃s:smt().
. | | . | . | . . |  s ∈ <s ∈ action_effect(a;A.eff;A.frame) |
. | | . | . | . . |       s.lbl =1 x>
. | | . | . | . . | by InstConcl [mk_smt(fr.var, fr.var, fr.typ)]
. | | . | . | . .
. | | . | . | . . |    THENA Auto

. | | . | . | . . THEN
. | | . | . | . . Unfold ‘action_effect‘ 0
. | | . | . | . .
. | | . | . | . . |    THENM RW ColMemberC 0
. | | . | . | . . THEN Reduce 0
. | | . | . | . .
. | | . | . | . . |    THEN Auto
. | | . | . | . . |
. | | . | . | . . 1. r : rel()
. | | . | . | . . 2. I : Collection(rel())
. | | . | . | . . 3. A : ioa{i:l}()
. | | . | . | . . 4. a : Label
. | | . | . | . . 5. r ∈ I
. | | . | . | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . . 7. x : Label
. | | . | . | . . 8. (x ∈ rel_primed_vars(r))
. | | . | . | . . 9. fr : frame()
. | | . | . | . . 10. fr ∈ A.frame
. | | . | . | . . 11. fr.var =1 x
. | | . | . | . . 12. ∀a:Label.
. | | . | . | . . |   (a ∈ fr.acts) ⇒
. | | . | . | . . |   (∃ef:eff().
. | | . | . | . . |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . . 13. ¬(a ∈ fr.acts)
. | | . | . | . . ⊢  (∃e:eff().
. | | . | . | . . |   e ∈ A.eff & e.kind =1 a
. | | . | . | . . |   & mk_smt(fr.var, fr.var, fr.typ) = e.smt)
. | | . | . | . . |  ∨ (∃f:frame().
. | | . | . | . . |     f ∈ A.frame & ¬2a ∈ f.acts
. | | . | . | . . |     & mk_smt(fr.var, fr.var, fr.typ)
. | | . | . | . . |       =
```

```
. | | . | . | . . |       mk_smt(f.var, f.var, f.typ))
. | | . | . | . . | by Sel 2 (D 0) THENA Auto
. | | . | . | . .
. | | . | . | . . |    THEN AutoInstConcl [] THEN Auto
. | | . | . | . . |
. | | . | . | . . 1. r : rel()
. | | . | . | . . 2. I : Collection(rel())
. | | . | . | . . 3. A : ioa{i:l}()
. | | . | . | . . 4. a : Label
. | | . | . | . . 5. r ∈ I
. | | . | . | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . . 7. x : Label
. | | . | . | . . 8. (x ∈ rel_primed_vars(r))
. | | . | . | . . 9. fr : frame()
. | | . | . | . . 10. fr ∈ A.frame
. | | . | . | . . 11. fr.var =1 x
. | | . | . | . . 12. ∀a:Label.
. | | . | . | . . |   (a ∈ fr.acts) ⇒
. | | . | . | . . |   (∃ef:eff().
. | | . | . | . . |    ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . . 13. ¬(a ∈ fr.acts)
. | | . | . | . . ⊢  ¬2a ∈ fr.acts
. | | . | . | . . | by RW assert_pushdownC 0 THEN Auto
. | | . | . | . . |
. | | . | . | . . 1. r : rel()
. | | . | . | . . 2. I : Collection(rel())
. | | . | . | . . 3. A : ioa{i:l}()
. | | . | . | . . 4. a : Label
. | | . | . | . . 5. r ∈ I
. | | . | . | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . | . . 7. x : Label
. | | . | . | . . 8. (x ∈ rel_primed_vars(r))
. | | . | . | . . 9. fr : frame()
. | | . | . | . . 10. fr ∈ A.frame
. | | . | . | . . 11. fr.var =1 x
. | | . | . | . . 12. ∀a:Label.
. | | . | . | . .     (a ∈ fr.acts) ⇒
. | | . | . | . .     (∃ef:eff().
. | | . | . | . .      ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . | . . 13. ¬(a ∈ fr.acts)
. | | . | . | . . ⊢  ¬a ∈ fr.acts
. | | . | . | . .   by RWW "assert_lbls_member" 0 THEN Auto
. | | . | . |
. | | . | . .\
. | | . | . . 1. r : rel()
. | | . | . . 2. I : Collection(rel())
. | | . | . . 3. A : ioa{i:l}()
. | | . | . . 4. a : Label
. | | . | . . 5. r ∈ I
. | | . | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . | . . 7. x : Label
. | | . | . . 8. (x ∈ rel_primed_vars(r))
. | | . | . . 9. fr : frame()
. | | . | . . 10. fr ∈ A.frame
. | | . | . . 11. fr.var =1 x
```

```
. | | . | . . 12. ∀a:Label.
. | | . | . .     (a ∈ fr.acts) ⇒
. | | . | . .     (∃ef:eff().
. | | . | . .      ef ∈ A.eff & ef.kind =1 a & ef.smt.lbl =1 x)
. | | . | . . 13. ∃s:smt().
. | | . | . .     s ∈ <s ∈ action_effect(a;A.eff;A.frame) |
. | | . | . .          s.lbl =1 x>
. | | . | . . ⊢  ∃t:Term.
. | | . | . .    (x ∈ rel_primed_vars(r)) ⇒
. | | . | . .    (∃s:smt().
. | | . | . .     s ∈ action_effect(a;A.eff;A.frame) & s.lbl =1 x
. | | . | . .     & t = s.term)
. | | . | . .   by ExRepD THEN
. | | . | . . All (RW ColMemberC) THEN

. | | . | . . InstConcl [
. | | . | . .      s.term] THENA Auto
. | | . | . . THEN D 0 THENA Auto
. | | . | . .
. | | . | . .      THEN InstConcl [s] THEN Auto
. | | . |
. | | . .\
. | | . . 1. r : rel()
. | | . . 2. I : Collection(rel())
. | | . . 3. A : ioa{i:l}()
. | | . . 4. a : Label
. | | . . 5. r ∈ I
. | | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | | . . 7. x : Label
. | | . . 8. ¬(x ∈ rel_primed_vars(r))
. | | . . ⊢  ∃t:Term.
. | | . .    (x ∈ rel_primed_vars(r)) ⇒
. | | . .    t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | | . .   by InstConcl [x] THEN Auto
. | |
. | .\
. | . 1. r : rel()
. | . 2. I : Collection(rel())
. | . 3. A : ioa{i:l}()
. | . 4. a : Label
. | . 5. r ∈ I
. | . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . 7. ∀x:Label.
. | . |  ∃t:Term.
. | . |  (x ∈ rel_primed_vars(r)) ⇒
. | . |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . ⊢  ∃as:(Label×Term) List.
. | . |  1of(unzip(as)) = rel_primed_vars(r)
. | . |  & (∀i:ℕ.
. | . |     i<||as|| ⇒
. | . |     2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);...))
. | . | by Assert ∃f:(Label→Term).
. | . |    ∀x:Label.
. | . |    (x ∈ rel_primed_vars(r)) ⇒
. | . |    f(x) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . |
```

```
. | . |\
. | . | .....assertion .....
. | . | 1. r : rel()
. | . | 2. I : Collection(rel())
. | . | 3. A : ioa{i:l}()
. | . | 4. a : Label
. | . | 5. r ∈ I
. | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . | 7. ∀x:Label.
. | . | |  ∃t:Term.
. | . | |  (x ∈ rel_primed_vars(r)) ⇒
. | . | |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | ⊢  ∃f:(Label→Term).
. | . | |  ∀x:Label.
. | . | |  (x ∈ rel_primed_vars(r)) ⇒
. | . | |  f(x) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | | by RenameVar 'g' (-1) THEN
. | . | InstConcl [λx.1of(g(x))
. | . | |    ] THEN Auto
. | . | THEN Reduce 0 THEN Auto
. | . | |
. | . | 1. r : rel()
. | . | 2. I : Collection(rel())
. | . | 3. A : ioa{i:l}()
. | . | 4. a : Label
. | . | 5. r ∈ I
. | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . | 7. g :
. | . | |  ∀x:Label.
. | . | |  ∃t:Term.
. | . | |  (x ∈ rel_primed_vars(r)) ⇒
. | . | |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | 8. x : Label
. | . | 9. (x ∈ rel_primed_vars(r))
. | . | ⊢  1of(g(x)) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | | by GenConcl  g(x) = z THEN Auto
. | . | |
. | . | 1. r : rel()
. | . | 2. I : Collection(rel())
. | . | 3. A : ioa{i:l}()
. | . | 4. a : Label
. | . | 5. r ∈ I
. | . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . | 7. g :
. | . |    ∀x:Label.
. | . |    ∃t:Term.
. | . |    (x ∈ rel_primed_vars(r)) ⇒
. | . |    t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | 8. x : Label
. | . | 9. (x ∈ rel_primed_vars(r))
. | . | 10. z :
. | . |     ∃t:Term.
. | . |     (x ∈ rel_primed_vars(r)) ⇒
. | . |     t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . | 11. g(x) = z
```

```
. | . | ⊢  1of(z) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . |   by D (-2) THEN All Reduce THEN BackThruSomeHyp THEN Auto
. | . |
. | . .\
. | . . 1. r : rel()
. | . . 2. I : Collection(rel())
. | . . 3. A : ioa{i:l}()
. | . . 4. a : Label
. | . . 5. r ∈ I
. | . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . . 7. ∀x:Label.
. | . . |  ∃t:Term.
. | . . |  (x ∈ rel_primed_vars(r)) ⇒
. | . . |  t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . 8. ∃f:(Label→Term).
. | . . |  ∀x:Label.
. | . . |  (x ∈ rel_primed_vars(r)) ⇒
. | . . |  f(x) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . ⊢  ∃as:(Label×Term) List.
. | . . |  1of(unzip(as)) = rel_primed_vars(r)
. | . . |  & (∀i:ℕ.
. | . . |     i<||as|| ⇒
. | . . |     2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;...);...))
. | . . | by ExRepD THEN InstConcl [
. | . . |    zip(rel_primed_vars(r);map(f;rel_primed_vars(r)))
. | . . |    ] THEN Auto
. | . . |
. | . . |\
. | . . | 1. r : rel()
. | . . | 2. I : Collection(rel())
. | . . | 3. A : ioa{i:l}()
. | . . | 4. a : Label
. | . . | 5. r ∈ I
. | . . | 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . . | 7. ∀x:Label.
. | . . |    ∃t:Term.
. | . . |    (x ∈ rel_primed_vars(r)) ⇒
. | . . |    t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . | 8. f : Label→Term
. | . . | 9. ∀x:Label.
. | . . |    (x ∈ rel_primed_vars(r)) ⇒
. | . . |    f(x) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . | ⊢  1of(unzip(zip(rel_primed_vars(r);map(f;...))))
. | . . |    =
. | . . |    rel_primed_vars(r)
. | . . |   by RW0 "unzip_zip" 0 THENM Reduce 0 THEN Auto
. | . . |
. | . . |      THEN RW0 "map_length_nat" 0
. | . . | THEN Auto•
. | . . |
. | . . .\
. | . . . 1. r : rel()
. | . . . 2. I : Collection(rel())
. | . . . 3. A : ioa{i:l}()
. | . . . 4. a : Label
```

```
. | . . . 5. r ∈ I
. | . . . 6. ∀x:Label. (x ∈ rel_vars(r)) ⇒ covers_var(A;x)
. | . . . 7. ∀x:Label.
. | . . .    ∃t:Term.
. | . . .    (x ∈ rel_primed_vars(r)) ⇒
. | . . .    t ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . . 8. f : Label→Term
. | . . . 9. ∀x:Label.
. | . . .    (x ∈ rel_primed_vars(r)) ⇒
. | . . .    f(x) ∈ smts_eff(action_effect(a;A.eff;A.frame);x)
. | . . . 10. i : ℕ
. | . . . 11. i<||zip(rel_primed_vars(r);map(f;rel_primed_vars(r)))||
. | . . . ⊢  ... ∈ smts_eff(action_effect(a;A.eff;A.frame);...)
. | . . .   by Assert i<||rel_primed_vars(r)||
. | . . .
. | . . .      THEN Try (RWO "length_zip" (-1) THEN Auto
. | . . .
. | . . .               THEN RWO "map_length_nat" 0
. | . . .
. | . . .               THEN Auto)
. | . . .
. | . . .      THEN RWO "select_zip" 0 THENM Reduce 0
. | . . .
. | . . .      THENM RWO "map_select" 0 THENA Auto
. | . . .
. | . . .      THEN Try (BackThruSomeHyp THEN
. | . . .
. | . . .                Unfold `l_member` 0 THEN InstConcl [i]
. | . . .
. | . . .                THEN Auto)
. |
. .\
. . 1. r : rel()
. . 2. I : Collection(rel())
. . 3. A : ioa{i:l}()
. . 4. a : Label
. . 5. r ∈ I
. . 6. ∀x:Label. rel_mentions(r;x) ⇒ covers_var(A;x)
. . 7. ∃as:(Label×Term) List.
. .    1of(unzip(as)) = rel_primed_vars(r)
. .    & (∀i:ℕ.
. .       i<||as|| ⇒
. .       2of(as[i]) ∈ smts_eff(action_effect(a;A.eff;A.frame);...))
. . ⊢  ∃r':rel(), as:(Label×Term) List.
. .    1of(unzip(as)) = rel_primed_vars(r)
. .    & (∀i:ℕ.
. .       i<||as|| ⇒
. .       2of(as[i]) ∈ (λx.smts_eff(action_effect(a;A.eff;A.frame);x))
. .                    (1of(as[i])))
. .    & r' = rel_subst2(as;r)
. .   by ExRepD THEN Reduce 0 THEN
. . InstConcl [rel_subst2(as;r);as
. .      ] THEN Auto
. . THEN Try (BackThruSomeHyp THEN Auto)
END
```