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# 1 conops0Solution Theory

**Built:** 05 March 2017

**Parent Theories:** aclDrules

## 1.1 Datatypes

*commands* = go | nogo | launch | abort | activate | stand\_down

*keyPrinc* =  
     Staff conops0Solution\$people  
     | Role conops0Solution\$roles  
     | Ap num

*people* = Alice | Bob

*principals* = PR keyPrinc | Key keyPrinc

*roles* = Commander | Operator | CA

## 1.2 Theorems

[ApRuleActivate\_thm]

```

⊢ (M, Oi, Os) sat
  Name (PR (Role Operator)) controls prop launch ⇒
  (M, Oi, Os) sat
  reps (Name (PR (Staff Bob))) (Name (PR (Role Operator)))
    (prop launch) ⇒
  (M, Oi, Os) sat
  Name (Key (Staff Bob)) quoting Name (PR (Role Operator)) says
  prop launch ⇒
  (M, Oi, Os) sat prop launch impf prop activate ⇒
  (M, Oi, Os) sat
  Name (Key (Role CA)) speaks_for Name (PR (Role CA)) ⇒
  (M, Oi, Os) sat
  Name (Key (Role CA)) says
  Name (Key (Staff Bob)) speaks_for Name (PR (Staff Bob)) ⇒
  (M, Oi, Os) sat
  Name (PR (Role CA)) controls
  Name (Key (Staff Bob)) speaks_for Name (PR (Staff Bob)) ⇒
  (M, Oi, Os) sat prop activate

```

[ApRuleStandDown\_thm]

```

⊢ (M, Oi, Os) sat Name (PR (Role Operator)) controls prop abort ⇒
  (M, Oi, Os) sat
  reps (Name (PR (Staff Bob))) (Name (PR (Role Operator)))
    (prop abort) ⇒
  (M, Oi, Os) sat

```

```

Name (Key (Staff Bob)) quoting Name (PR (Role Operator)) says
prop abort ⇒
(M, Oi, Os) sat prop abort impf prop stand_down ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) speaks_for Name (PR (Role CA)) ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) says
Name (Key (Staff Bob)) speaks_for Name (PR (Staff Bob)) ⇒
(M, Oi, Os) sat
Name (PR (Role CA)) controls
Name (Key (Staff Bob)) speaks_for Name (PR (Staff Bob)) ⇒
(M, Oi, Os) sat prop stand_down

```

#### [OpRuleAbort\_thm]

```

⊢ (M, Oi, Os) sat Name (PR (Role Commander)) controls prop nogo ⇒
(M, Oi, Os) sat
reps (Name (PR (Staff Alice))) (Name (PR (Role Commander)))
(prop nogo) ⇒
(M, Oi, Os) sat
Name (Key (Staff Alice)) quoting
Name (PR (Role Commander)) says prop nogo ⇒
(M, Oi, Os) sat prop nogo impf prop abort ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) speaks_for Name (PR (Role CA)) ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) says
Name (Key (Staff Alice)) speaks_for Name (PR (Staff Alice)) ⇒
(M, Oi, Os) sat
Name (Key (Staff Bob)) quoting Name (PR (Role Operator)) says
prop abort

```

#### [OpRuleLaunch\_thm]

```

⊢ (M, Oi, Os) sat Name (PR (Role Commander)) controls prop go ⇒
(M, Oi, Os) sat
reps (Name (PR (Staff Alice))) (Name (PR (Role Commander)))
(prop go) ⇒
(M, Oi, Os) sat
Name (Key (Staff Alice)) quoting
Name (PR (Role Commander)) says prop go ⇒
(M, Oi, Os) sat prop go impf prop launch ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) speaks_for Name (PR (Role CA)) ⇒
(M, Oi, Os) sat
Name (Key (Role CA)) says
Name (Key (Staff Alice)) speaks_for Name (PR (Staff Alice)) ⇒
(M, Oi, Os) sat
Name (PR (Role CA)) controls
Name (Key (Staff Alice)) speaks_for Name (PR (Staff Alice)) ⇒
(M, Oi, Os) sat

```

Name (Key (Staff Bob)) quoting Name (PR (Role Operator)) says  
prop launch

## 2 aclrules Theory

**Built:** 04 March 2017

**Parent Theories:** aclsemantics

### 2.1 Definitions

[sat\_def]

$$\vdash \forall M \ Oi \ Os \ f. (M, Oi, Os) \text{ sat } f \iff (\text{Efn } Oi \ Os \ M \ f = \mathcal{U}(:'world))$$

### 2.2 Theorems

[And\_Says]

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ meet } Q \text{ says } f \text{ eqf } P \text{ says } f \text{ andf } Q \text{ says } f$$

[And\_Says\_Eq]

$$\vdash (M, Oi, Os) \text{ sat } P \text{ meet } Q \text{ says } f \iff \\ (M, Oi, Os) \text{ sat } P \text{ says } f \text{ andf } Q \text{ says } f$$

[and\_says\_lemma]

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ meet } Q \text{ says } f \text{ impf } P \text{ says } f \text{ andf } Q \text{ says } f$$

[Controls\_Eq]

$$\vdash \forall M \ Oi \ Os \ P \ f. \\ (M, Oi, Os) \text{ sat } P \text{ controls } f \iff (M, Oi, Os) \text{ sat } P \text{ says } f \text{ impf } f$$

[DIFF\_UNIV\_SUBSET]

$$\vdash (\mathcal{U}(:'a) \text{ DIFF } s \cup t = \mathcal{U}(:'a)) \iff s \subseteq t$$

[domi\_antisymmetric]

$$\vdash \forall M \ Oi \ Os \ l_1 \ l_2. \\ (M, Oi, Os) \text{ sat } l_1 \text{ domi } l_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } l_2 \text{ domi } l_1 \Rightarrow \\ (M, Oi, Os) \text{ sat } l_1 \text{ eqi } l_2$$

[domi\_reflexive]

$$\vdash \forall M \ Oi \ Os \ l. (M, Oi, Os) \text{ sat } l \text{ domi } l$$

**[domi\_transitive]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ l_1 \ l_2 \ l_3. \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ domi } l_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ domi } l_3 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ domi } l_3 \end{aligned}$$
**[doms\_antisymmetric]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ l_1 \ l_2. \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ doms } l_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ doms } l_1 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ eqs } l_2 \end{aligned}$$
**[doms\_reflexive]**

$$\vdash \forall M \ Oi \ Os \ l. (M, Oi, Os) \text{ sat } l \text{ doms } l$$
**[doms\_transitive]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ l_1 \ l_2 \ l_3. \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ doms } l_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ doms } l_3 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ doms } l_3 \end{aligned}$$
**[eqf\_and\_impf]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f_1 \ f_2. \\ &\quad (M, Oi, Os) \text{ sat } f_1 \text{ eqf } f_2 \iff \\ &\quad (M, Oi, Os) \text{ sat } (f_1 \text{ impf } f_2) \text{ andf } (f_2 \text{ impf } f_1) \end{aligned}$$
**[eqf\_andf1]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f \text{ andf } g \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f' \text{ andf } g \end{aligned}$$
**[eqf\_andf2]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ andf } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ andf } f' \end{aligned}$$
**[eqf\_controls]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ P \ f \ f'. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ controls } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ controls } f' \end{aligned}$$
**[eqf\_eq]**

$$\begin{aligned} &\vdash (\text{Efn } Oi \ Os \ M \ (f_1 \text{ eqf } f_2) = \mathcal{U}(:'b)) \iff \\ &\quad (\text{Efn } Oi \ Os \ M \ f_1 = \text{Efn } Oi \ Os \ M \ f_2) \end{aligned}$$

**[eqf\_eqf1]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } g \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f' \text{ eqf } g \end{aligned}$$
**[eqf\_eqf2]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ eqf } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ eqf } f' \end{aligned}$$
**[eqf\_impf1]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f \text{ impf } g \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f' \text{ impf } g \end{aligned}$$
**[eqf\_impf2]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ impf } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ impf } f' \end{aligned}$$
**[eqf\_notf]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f'. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat notf } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat notf } f' \end{aligned}$$
**[eqf\_orf1]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f \text{ orf } g \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f' \text{ orf } g \end{aligned}$$
**[eqf\_orf2]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f \ f' \ g. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ orf } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } g \text{ orf } f' \end{aligned}$$
**[eqf\_reps]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ P \ Q \ f \ f'. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat reps } P \ Q \ f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat reps } P \ Q \ f' \end{aligned}$$

**[eqf\_sat]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f_1 \ f_2. \\ &\quad (M, Oi, Os) \text{ sat } f_1 \text{ eqf } f_2 \Rightarrow \\ &\quad ((M, Oi, Os) \text{ sat } f_1 \iff (M, Oi, Os) \text{ sat } f_2) \end{aligned}$$
**[eqf\_says]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ P \ f \ f'. \\ &\quad (M, Oi, Os) \text{ sat } f \text{ eqf } f' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ says } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ says } f' \end{aligned}$$
**[eqi\_Eq]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ l_1 \ l_2. \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ eqi } l_2 \iff \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ domi } l_1 \text{ andf } l_1 \text{ domi } l_2 \end{aligned}$$
**[eqs\_Eq]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ l_1 \ l_2. \\ &\quad (M, Oi, Os) \text{ sat } l_1 \text{ eqs } l_2 \iff \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ doms } l_1 \text{ andf } l_1 \text{ doms } l_2 \end{aligned}$$
**[Idemp\_Speaks\_For]**

$$\vdash \forall M \ Oi \ Os \ P. (M, Oi, Os) \text{ sat } P \text{ speaks\_for } P$$
**[Image\_cmp]**

$$\vdash \forall R_1 \ R_2 \ R_3 \ u. (R_1 \ 0 \ R_2) \ u \subseteq R_3 \iff R_2 \ u \subseteq \{y \mid R_1 \ y \subseteq R_3\}$$
**[Image\_SUBSET]**

$$\vdash \forall R_1 \ R_2. R_2 \text{ RSUBSET } R_1 \Rightarrow \forall w. R_2 \ w \subseteq R_1 \ w$$
**[Image\_UNION]**

$$\vdash \forall R_1 \ R_2 \ w. (R_1 \text{ RUNION } R_2) \ w = R_1 \ w \cup R_2 \ w$$
**[INTER\_EQ\_UNIV]**

$$\vdash (s \cap t = \mathcal{U}(:'a)) \iff (s = \mathcal{U}(:'a)) \wedge (t = \mathcal{U}(:'a))$$
**[Modus\_Ponens]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ f_1 \ f_2. \\ &\quad (M, Oi, Os) \text{ sat } f_1 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f_1 \text{ impf } f_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f_2 \end{aligned}$$
**[Mono\_speaks\_for]**

$$\begin{aligned} &\vdash \forall M \ Oi \ Os \ P \ P' \ Q \ Q'. \\ &\quad (M, Oi, Os) \text{ sat } P \text{ speaks\_for } P' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } Q \text{ speaks\_for } Q' \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ speaks\_for } P' \text{ quoting } Q' \end{aligned}$$



**[MP\_Says]**

$$\vdash \forall M \ Oi \ Os \ P \ f_1 \ f_2. \\ (M, Oi, Os) \text{ sat} \\ P \text{ says } (f_1 \text{ impf } f_2) \text{ impf } P \text{ says } f_1 \text{ impf } P \text{ says } f_2$$
**[Quoting]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ says } f \text{ eqf } P \text{ says } Q \text{ says } f$$
**[Quoting\_Eq]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ says } f \iff \\ (M, Oi, Os) \text{ sat } P \text{ says } Q \text{ says } f$$
**[reps\_def\_lemma]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ \text{Efn } Oi \ Os \ M \ (\text{reps } P \ Q \ f) = \\ \text{Efn } Oi \ Os \ M \ (P \text{ quoting } Q \text{ says } f \text{ impf } Q \text{ says } f)$$
**[Reps\_Eq]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } \text{reps } P \ Q \ f \iff \\ (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ says } f \text{ impf } Q \text{ says } f$$
**[sat\_allworld]**

$$\vdash \forall M \ f. (M, Oi, Os) \text{ sat } f \iff \forall w. w \in \text{Efn } Oi \ Os \ M \ f$$
**[sat\_andf\_eq\_and\_sat]**

$$\vdash (M, Oi, Os) \text{ sat } f_1 \text{ andf } f_2 \iff \\ (M, Oi, Os) \text{ sat } f_1 \wedge (M, Oi, Os) \text{ sat } f_2$$
**[sat\_TT]**

$$\vdash (M, Oi, Os) \text{ sat } \text{TT}$$
**[Says]**

$$\vdash \forall M \ Oi \ Os \ P \ f. (M, Oi, Os) \text{ sat } f \Rightarrow (M, Oi, Os) \text{ sat } P \text{ says } f$$
**[says\_and\_lemma]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ says } f \text{ andf } Q \text{ says } f \text{ impf } P \text{ meet } Q \text{ says } f$$
**[Speaks\_For]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ f. \\ (M, Oi, Os) \text{ sat } P \text{ speaks\_for } Q \text{ impf } P \text{ says } f \text{ impf } Q \text{ says } f$$

**[speaks\_for\_SUBSET]**

$$\vdash \forall R_3 \ R_2 \ R_1. \\ R_2 \text{ RSUBSET } R_1 \Rightarrow \forall w. \{w \mid R_1 \ w \subseteq R_3\} \subseteq \{w \mid R_2 \ w \subseteq R_3\}$$

**[SUBSET\_Image\_SUBSET]**

$$\vdash \forall R_1 \ R_2 \ R_3. \\ (\forall w_1. R_2 \ w_1 \subseteq R_1 \ w_1) \Rightarrow \\ \forall w. \{w \mid R_1 \ w \subseteq R_3\} \subseteq \{w \mid R_2 \ w \subseteq R_3\}$$

**[Trans\_Speaks\_For]**

$$\vdash \forall M \ Oi \ Os \ P \ Q \ R. \\ (M, Oi, Os) \text{ sat } P \text{ speaks\_for } Q \Rightarrow \\ (M, Oi, Os) \text{ sat } Q \text{ speaks\_for } R \Rightarrow \\ (M, Oi, Os) \text{ sat } P \text{ speaks\_for } R$$

**[UNIV\_DIFF\_SUBSET]**

$$\vdash \forall R_1 \ R_2. \ R_1 \subseteq R_2 \Rightarrow (\mathcal{U}(:'a) \text{ DIFF } R_1 \cup R_2 = \mathcal{U}(:'a))$$

**[world\_and]**

$$\vdash \forall M \ Oi \ Os \ f_1 \ f_2 \ w. \\ w \in \text{Efn } Oi \ Os \ M \ (f_1 \text{ andf } f_2) \iff \\ w \in \text{Efn } Oi \ Os \ M \ f_1 \wedge w \in \text{Efn } Oi \ Os \ M \ f_2$$

**[world\_eq]**

$$\vdash \forall M \ Oi \ Os \ f_1 \ f_2 \ w. \\ w \in \text{Efn } Oi \ Os \ M \ (f_1 \text{ eqf } f_2) \iff \\ (w \in \text{Efn } Oi \ Os \ M \ f_1 \iff w \in \text{Efn } Oi \ Os \ M \ f_2)$$

**[world\_eqn]**

$$\vdash \forall M \ Oi \ Os \ n_1 \ n_2 \ w. \ w \in \text{Efn } Oi \ Os \ m \ (n_1 \text{ eqn } n_2) \iff (n_1 = n_2)$$

**[world\_F]**

$$\vdash \forall M \ Oi \ Os \ w. \ w \notin \text{Efn } Oi \ Os \ M \text{ FF}$$

**[world\_imp]**

$$\vdash \forall M \ Oi \ Os \ f_1 \ f_2 \ w. \\ w \in \text{Efn } Oi \ Os \ M \ (f_1 \text{ impf } f_2) \iff \\ w \in \text{Efn } Oi \ Os \ M \ f_1 \Rightarrow w \in \text{Efn } Oi \ Os \ M \ f_2$$

**[world\_lt]**

$$\vdash \forall M \ Oi \ Os \ n_1 \ n_2 \ w. \ w \in \text{Efn } Oi \ Os \ m \ (n_1 \text{ lt } n_2) \iff n_1 < n_2$$

**[world\_lte]**

$$\vdash \forall M \ Oi \ Os \ n_1 \ n_2 \ w. \ w \in \text{Efn } Oi \ Os \ m \ (n_1 \text{ lte } n_2) \iff n_1 \leq n_2$$

[world\_not]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } f \text{ } w. w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } (\text{notf } f) \iff w \notin \text{Efn } Oi \text{ } Os \text{ } M \text{ } f$

[world\_or]

$\vdash \forall M \text{ } f_1 \text{ } f_2 \text{ } w.$   
 $w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } (f_1 \text{ orf } f_2) \iff$   
 $w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } f_1 \vee w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } f_2$

[world\_says]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } P \text{ } f \text{ } w.$   
 $w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } (P \text{ says } f) \iff$   
 $\forall v. v \in \text{Jext } (\text{jKS } M) \text{ } P \text{ } w \Rightarrow v \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } f$

[world\_T]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } w. w \in \text{Efn } Oi \text{ } Os \text{ } M \text{ } \text{TT}$

### 3 aclDrules Theory

**Built:** 04 March 2017

**Parent Theories:** aclrules

#### 3.1 Theorems

[Conjunction]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } f_1 \text{ } f_2.$   
 $(M, Oi, Os) \text{ sat } f_1 \Rightarrow$   
 $(M, Oi, Os) \text{ sat } f_2 \Rightarrow$   
 $(M, Oi, Os) \text{ sat } f_1 \text{ andf } f_2$

[Controls]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } P \text{ } f.$   
 $(M, Oi, Os) \text{ sat } P \text{ says } f \Rightarrow$   
 $(M, Oi, Os) \text{ sat } P \text{ controls } f \Rightarrow$   
 $(M, Oi, Os) \text{ sat } f$

[Derived\_Controls]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } P \text{ } Q \text{ } f.$   
 $(M, Oi, Os) \text{ sat } P \text{ speaks\_for } Q \Rightarrow$   
 $(M, Oi, Os) \text{ sat } Q \text{ controls } f \Rightarrow$   
 $(M, Oi, Os) \text{ sat } P \text{ controls } f$

[Derived\_Speaks\_For]

$\vdash \forall M \text{ } Oi \text{ } Os \text{ } P \text{ } Q \text{ } f.$   
 $(M, Oi, Os) \text{ sat } P \text{ speaks\_for } Q \Rightarrow$   
 $(M, Oi, Os) \text{ sat } P \text{ says } f \Rightarrow$   
 $(M, Oi, Os) \text{ sat } Q \text{ says } f$

**[Disjunction1]**

$$\vdash \forall M \ Oi \ Os \ f_1 \ f_2. (M, Oi, Os) \text{ sat } f_1 \Rightarrow (M, Oi, Os) \text{ sat } f_1 \text{ orf } f_2$$
**[Disjunction2]**

$$\vdash \forall M \ Oi \ Os \ f_1 \ f_2. (M, Oi, Os) \text{ sat } f_2 \Rightarrow (M, Oi, Os) \text{ sat } f_1 \text{ orf } f_2$$
**[Disjunctive\_Syllogism]**

$$\begin{aligned} \vdash \forall M \ Oi \ Os \ f_1 \ f_2. \\ (M, Oi, Os) \text{ sat } f_1 \text{ orf } f_2 \Rightarrow \\ (M, Oi, Os) \text{ sat notf } f_1 \Rightarrow \\ (M, Oi, Os) \text{ sat } f_2 \end{aligned}$$
**[Double\_Negation]**

$$\vdash \forall M \ Oi \ Os \ f. (M, Oi, Os) \text{ sat notf (notf } f) \Rightarrow (M, Oi, Os) \text{ sat } f$$
**[eqn\_eqn]**

$$\begin{aligned} \vdash (M, Oi, Os) \text{ sat } c_1 \text{ eqn } n_1 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_2 \text{ eqn } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } n_1 \text{ eqn } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_1 \text{ eqn } c_2 \end{aligned}$$
**[eqn\_lt]**

$$\begin{aligned} \vdash (M, Oi, Os) \text{ sat } c_1 \text{ eqn } n_1 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_2 \text{ eqn } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } n_1 \text{ lt } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_1 \text{ lt } c_2 \end{aligned}$$
**[eqn\_lte]**

$$\begin{aligned} \vdash (M, Oi, Os) \text{ sat } c_1 \text{ eqn } n_1 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_2 \text{ eqn } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } n_1 \text{ lte } n_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } c_1 \text{ lte } c_2 \end{aligned}$$
**[Hypothetical\_Syllogism]**

$$\begin{aligned} \vdash \forall M \ Oi \ Os \ f_1 \ f_2 \ f_3. \\ (M, Oi, Os) \text{ sat } f_1 \text{ impf } f_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } f_2 \text{ impf } f_3 \Rightarrow \\ (M, Oi, Os) \text{ sat } f_1 \text{ impf } f_3 \end{aligned}$$
**[il\_domi]**

$$\begin{aligned} \vdash \forall M \ Oi \ Os \ P \ Q \ l_1 \ l_2. \\ (M, Oi, Os) \text{ sat il } P \text{ eqi } l_1 \Rightarrow \\ (M, Oi, Os) \text{ sat il } Q \text{ eqi } l_2 \Rightarrow \\ (M, Oi, Os) \text{ sat } l_2 \text{ domi } l_1 \Rightarrow \\ (M, Oi, Os) \text{ sat il } Q \text{ domi il } P \end{aligned}$$

**[INTER\_EQ\_UNIV]**

$$\vdash \forall s_1 s_2. (s_1 \cap s_2 = \mathcal{U}(:'a)) \iff (s_1 = \mathcal{U}(:'a)) \wedge (s_2 = \mathcal{U}(:'a))$$
**[Modus\_Tollens]**

$$\begin{aligned} &\vdash \forall M Oi Os f_1 f_2. \\ &\quad (M, Oi, Os) \text{ sat } f_1 \text{ impf } f_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat notf } f_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat notf } f_1 \end{aligned}$$
**[Rep\_Controls\_Eq]**

$$\begin{aligned} &\vdash \forall M Oi Os A B f. \\ &\quad (M, Oi, Os) \text{ sat reps } A B f \iff \\ &\quad (M, Oi, Os) \text{ sat } A \text{ controls } B \text{ says } f \end{aligned}$$
**[Rep\_Says]**

$$\begin{aligned} &\vdash \forall M Oi Os P Q f. \\ &\quad (M, Oi, Os) \text{ sat reps } P Q f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ says } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } Q \text{ says } f \end{aligned}$$
**[Reps]**

$$\begin{aligned} &\vdash \forall M Oi Os P Q f. \\ &\quad (M, Oi, Os) \text{ sat reps } P Q f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } P \text{ quoting } Q \text{ says } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } Q \text{ controls } f \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } f \end{aligned}$$
**[Says\_Simplification1]**

$$\begin{aligned} &\vdash \forall M Oi Os P f_1 f_2. \\ &\quad (M, Oi, Os) \text{ sat } P \text{ says } (f_1 \text{ andf } f_2) \Rightarrow (M, Oi, Os) \text{ sat } P \text{ says } f_1 \end{aligned}$$
**[Says\_Simplification2]**

$$\begin{aligned} &\vdash \forall M Oi Os P f_1 f_2. \\ &\quad (M, Oi, Os) \text{ sat } P \text{ says } (f_1 \text{ andf } f_2) \Rightarrow (M, Oi, Os) \text{ sat } P \text{ says } f_2 \end{aligned}$$
**[Simplification1]**

$$\vdash \forall M Oi Os f_1 f_2. (M, Oi, Os) \text{ sat } f_1 \text{ andf } f_2 \Rightarrow (M, Oi, Os) \text{ sat } f_1$$
**[Simplification2]**

$$\vdash \forall M Oi Os f_1 f_2. (M, Oi, Os) \text{ sat } f_1 \text{ andf } f_2 \Rightarrow (M, Oi, Os) \text{ sat } f_2$$
**[sl\_doms]**

$$\begin{aligned} &\vdash \forall M Oi Os P Q l_1 l_2. \\ &\quad (M, Oi, Os) \text{ sat sl } P \text{ eqs } l_1 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat sl } Q \text{ eqs } l_2 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat } l_2 \text{ doms } l_1 \Rightarrow \\ &\quad (M, Oi, Os) \text{ sat sl } Q \text{ doms sl } P \end{aligned}$$



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