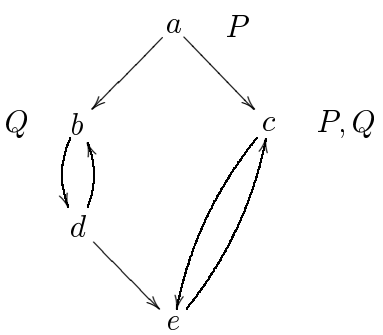
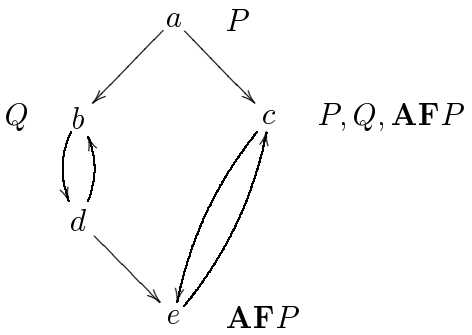
Tik-79.146 **Kevät 1999**
Logiikka tietotekniikassa: erityiskysymyksiä I
Laskuharjoitus 11
Ratkaisut

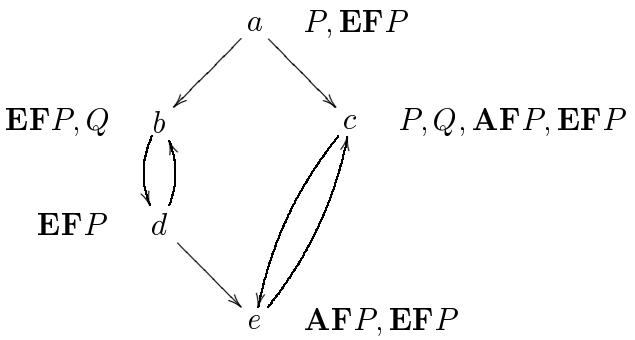
1. M :



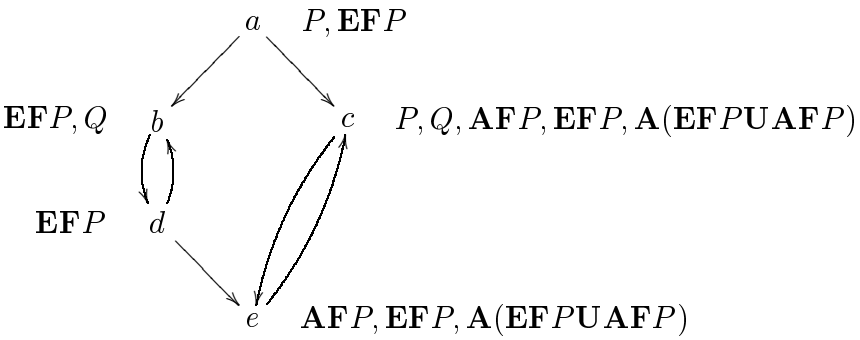
Lisätään $\mathbf{AF}P$:



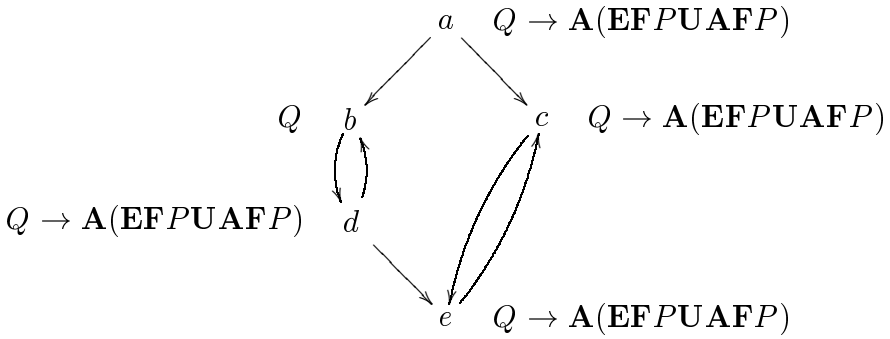
Lisätään $\mathbf{EF}P$:



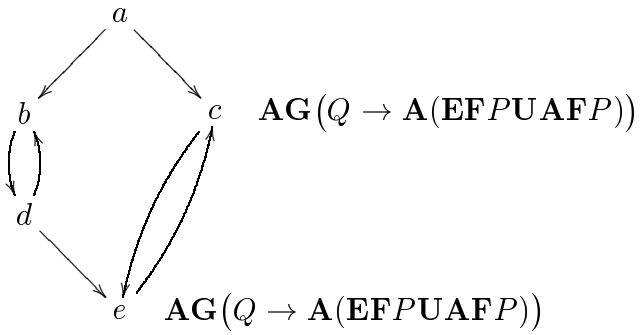
Lisätään $\mathbf{A}(\mathbf{EF}P\mathbf{U}\mathbf{AF}P)$:



Lisätään $Q \rightarrow \mathbf{A}(\mathbf{EF}P\mathbf{U}\mathbf{AF}P)$:



Lisätään $\mathbf{AG}\big(Q \rightarrow \mathbf{A}(\mathbf{EF}P\mathbf{U}\mathbf{AF}P)\big)$:



2. Aloitetaan lauseen negaatiosta

$$\neg\Big(\Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q)\big)\Big) \rightarrow \mathbf{A}(P\mathbf{U}Q)\Big)$$

Muunnetaan lause positiiviseen normaalimuotoon

$$\Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q)\big)\Big) \wedge \neg\mathbf{A}(P\mathbf{U}Q)$$

$$\Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q)\big)\Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q)$$

Rakennetaan taulu.

$$D_0 = \Big\{ \Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big) \Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q) \Big\}$$

D_0:n AND-seuraajat:

$$\begin{aligned}
C_0 = \Big\{ & \Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big) \Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big), \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q, \neg Q, \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \neg P \Big\} \\
C_1 = \Big\{ & \Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big) \Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big), \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q, \neg Q, \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \mathbf{EXE}(\neg P\mathbf{B}Q) \Big\} \\
C_2 = \Big\{ & \Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big) \Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big), \mathbf{E}(\neg P\mathbf{B}Q), \\
& P \wedge \mathbf{AXA}(P\mathbf{U}Q), P, \mathbf{AXA}(P\mathbf{U}Q), \neg Q, \\
& \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \neg P \Big\} \\
C_3 = \Big\{ & \Big(Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big) \Big) \wedge \mathbf{E}(\neg P\mathbf{B}Q), \\
& Q \vee \big(P \wedge \mathbf{AXA}(P\mathbf{U}Q) \big), \mathbf{E}(\neg P\mathbf{B}Q), \\
& P \wedge \mathbf{AXA}(P\mathbf{U}Q), P, \mathbf{AXA}(P\mathbf{U}Q), \neg Q, \\
& \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \mathbf{EXE}(\neg P\mathbf{B}Q) \Big\}
\end{aligned}$$

C_0–C_2 karsitaan pois.

C_3:n OR-seuraaja: $D_1 = \{\mathbf{A}(P\mathbf{U}Q), \mathbf{E}(\neg P\mathbf{B}Q)\}$

D_1:n AND-seuraajat:

$$\begin{aligned}
C_4 &= D_1 \cup \{Q, \neg Q, \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \neg P\} \\
C_5 &= D_1 \cup \{Q, \neg Q, \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \mathbf{EXE}(\neg P\mathbf{B}Q)\} \\
C_6 &= D_1 \cup \{P \wedge \mathbf{AXA}(P\mathbf{U}Q), P, \mathbf{AXA}(P\mathbf{U}Q), \neg Q, \\
&\qquad \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \neg P\} \\
C_7 &= D_1 \cup \{P \wedge \mathbf{AXA}(P\mathbf{U}Q), P, \mathbf{AXA}(P\mathbf{U}Q), \neg Q, \\
&\qquad \neg P \vee \mathbf{EXE}(\neg P\mathbf{B}Q), \mathbf{EXE}(\neg P\mathbf{B}Q)\}
\end{aligned}$$

C_4–C_6 karsitaan pois.

C_7:n OR-seuraaja: D_1

C_7 voidaan karsia pois koska tulevaisuuslause $\mathbf{A}(P\mathbf{U}Q)$ ei toteudu (Q ei koskaan tosi). Tämän jälkeen karsitaan D_1, C_3 ja D_0, joten jäljellä jää tyhjä graafi. Tällöin alkuperäinen lause on pätevä.

3. Lause

$$\mathbf{AG}(req \rightarrow \mathbf{AF}ack) \wedge \mathbf{EF}req \wedge \mathbf{AF}\neg ack$$

on jo positiivisessä normaalimuodossa. Rakennetaan taulu.

$$D_0 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack) \wedge \mathbf{EF}req \wedge \mathbf{AF}\neg ack\}$$

D_0:n AND-seuraajat:

$$C_0 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, req, \neg ack\}$$
$$C_1 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, req, \neg ack\}$$
$$C_2 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, req, \neg ack\}$$
$$C_3 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{EXEF}req, \neg ack\}$$
$$C_4 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{EXEF}req, \neg ack\}$$
$$C_5 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, \mathbf{EXEF}req, \neg ack\}$$
$$C_6 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, req, \mathbf{AXAF}\neg ack\}$$
$$C_7 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, req, \mathbf{AXAF}\neg ack\}$$
$$C_8 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, req, \mathbf{AXAF}\neg ack\}$$
$$C_9 = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$$
$$C_{10} = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$$
$$C_{11} = D_0 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, \mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$$

Karsitaan C_0, C_1, C_4 ja C_6

C_2:n OR-seuraaja: $D_1 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack\}$
C_3:n OR-seuraaja: $D_2 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{EF}req\}$

C_5:n OR-seuraaja: $D_3 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{EF}req\}$
C_7:n OR-seuraaja: $D_4 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}\neg ack\}$
C_8:n OR-seuraaja: $D_5 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AF}\neg ack\}$
C_9:n OR-seuraaja: D_0
C_{10}:n OR-seuraaja: D_0
C_{11}:n OR-seuraaja: $D_6 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{EF}req, \mathbf{AF}\neg ack\}$

D_1:n AND-seuraajat:

$C_{12} = D_1 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req\}$
$C_{13} = D_1 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req\}$
$C_{14} = D_1 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack\}$
$C_{15} = D_1 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack\}$

D_2:n AND-seuraajat:

$C_{16} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, req\}$
$C_{17} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{EXEF}req\}$
$C_{18} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, req\}$
$C_{19} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{EXEF}req\}$
$C_{20} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, req\}$
$C_{21} = D_2 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, \mathbf{EXEF}req\}$

Karsitaan C_{16}.

D_3:n AND-seuraajat:

$C_{22} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req, req\}$
$C_{23} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req, req\}$
$C_{18} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, req\}$
$C_{20} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, req\}$
$C_{24} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req, \mathbf{EXEF}req\}$
$C_{25} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req, \mathbf{EXEF}req\}$
$C_{19} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \mathbf{EXEF}req\}$
$C_{21} = D_3 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \mathbf{EXEF}req\}$

Karsitaan C_{22}, C_{23}.

D_4:n AND-seuraajat:

$C_{26} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \neg ack\}$
$C_{27} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{AXAF}\neg ack\}$
$C_{28} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \neg ack\}$
$C_{29} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{AXAF}\neg ack\}$
$C_{30} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, \neg ack\}$
$C_{31} = D_4 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, \mathbf{AXAF}\neg ack\}$

Karsitaan C_{28}.

D_5:n AND-seuraajat:

$C_{32} = D_5 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \neg ack, ack\}$
$C_{33} = D_5 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \neg ack, \mathbf{AXAF}ack\}$
$C_{34} = D_5 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{AXAF}\neg ack, ack\}$
$C_{35} = D_5 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{AXAF}\neg ack, \mathbf{AXAF}ack\}$
C_{28}
C_{29}
C_{30}
C_{31}

Karsitaan C_{32} ja C_{28}.

D_6:n AND-seuraajat:

$C_{36} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req, req, \neg ack\}$
$C_{37} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req, req, \neg ack\}$
$C_{38} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, req, \neg ack\}$
$C_{39} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, req, \neg ack\}$
$C_{40} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req, \mathbf{EXEF}req, \neg ack\}$
$C_{41} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req,$
$\quad \mathbf{EXEF}req, \neg ack\}$
$C_{42} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \mathbf{EXEF}req, \neg ack\}$
$C_{43} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \mathbf{EXEF}req, \neg ack\}$
$C_{44} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req, req, \mathbf{AXAF}\neg ack\}$
$C_{45} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req, req,$
$\quad \mathbf{AXAF}\neg ack\}$
$C_{46} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, req, \mathbf{AXAF}\neg ack\}$

$C_{47} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, req, \mathbf{AXAF}\neg ack\}$
$C_{48} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \neg req,$
$\mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$
$C_{49} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack, \neg req,$
$\mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$
$C_{50} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), ack, \mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$
$C_{51} = D_6 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AXAF}ack,$
$\mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$

Karsitaan C_{36}, C_{37}, C_{38}, C_{40}, C_{42}, C_{44}, C_{45}.

C_{12}:n OR-seuraaja: $D_7 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack)\}$
C_{13}:n OR-seuraaja: D_1
C_{14}:n OR-seuraaja: D_7
C_{15}:n OR-seuraaja: D_1
C_{17}:n OR-seuraaja: D_2
C_{18}:n OR-seuraaja: D_7
C_{19}:n OR-seuraaja: D_2
C_{20}:n OR-seuraaja: D_1
C_{21}:n OR-seuraaja: D_3
C_{24}:n OR-seuraaja: D_2
C_{25}:n OR-seuraaja: D_3
C_{26}:n OR-seuraaja: D_7
C_{27}:n OR-seuraaja: D_4
C_{29}:n OR-seuraaja: D_4
C_{30}:n OR-seuraaja: D_1
C_{31}:n OR-seuraaja: D_5
C_{33}:n OR-seuraaja: D_1
C_{34}:n OR-seuraaja: D_4
C_{35}:n OR-seuraaja: D_5
C_{39}:n OR-seuraaja: D_1
C_{41}:n OR-seuraaja: D_3
C_{43}:n OR-seuraaja: D_3
C_{46}:n OR-seuraaja: D_4
C_{47}:n OR-seuraaja: D_5
C_{48}:n OR-seuraaja: $D_8 = \{\mathbf{AG}(req \rightarrow \mathbf{AF}ack), \mathbf{EF}req, \mathbf{AF}\neg ack\}$
C_{49}:n OR-seuraaja: D_6
C_{50}:n OR-seuraaja: D_8
C_{51}:n OR-seuraaja: D_6

D_7:n AND-seuraajat:

$C_{52} = D_7 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req\}$
$C_{14} = D_7 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack\}$
$C_{15} = D_7 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack\}$

D_8:n AND-seuraajat:

$C_{53} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, req, \neg ack\}$
$C_{54} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{EXEF}req, \neg ack\}$
$C_{38} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, req, \neg ack\}$
$C_{42} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{EXEF}req, \neg ack\}$
$C_{39} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack, req, \neg ack\}$
$C_{43} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack,$
$\mathbf{AXAF}ack, \mathbf{EXEF}req, \neg ack\}$
$C_{55} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, req, \mathbf{AXAF}\neg ack\}$
$C_{56} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \neg req, \mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$
$C_{46} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, req, \mathbf{AXAF}\neg ack\}$
$C_{50} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, ack, \mathbf{EXEF}req,$
$\mathbf{AXAF}\neg ack\}$
$C_{47} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack,$
$req, \mathbf{AXAF}\neg ack\}$
$C_{51} = D_8 \cup \{req \rightarrow \mathbf{AF}ack, \mathbf{AXAG}(req \rightarrow \mathbf{AF}ack), \mathbf{AF}ack, \mathbf{AXAF}ack,$
$\mathbf{EXEF}req, \mathbf{AXAF}\neg ack\}$

Karsitaan C_{38}, C_{42}, C_{53}, C_{55}.

C_{52}:n OR-seuraaja: D_7
C_{54}:n OR-seuraaja: D_2
C_{56}:n OR-seuraaja: D_8

Tulevaisuuslause $\mathbf{AF}ack$ ei toteudu solmuissa C_{13} ja C_{15} ja niitä voidaan karsia. Mm. solmut C_2, C_{12}, C_{14}, C_{52}, D_7, D_1 ja D_0 jäävät graafiin, joten lause $\mathbf{AG}(req \rightarrow \mathbf{AF}ack) \wedge \mathbf{EF}req \wedge \mathbf{AF}\neg ack$ on toteutuva.

Malli:

$req, \neg ack$ s $\circlearrowleft$ t $\neg req, ack$