Communication and Concurrency
Lecture 3

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Transition rules (including axioms)

$$\mathrm{R}(.) \quad a.E \xrightarrow{a} E$$

$$\mathrm{R}(\mathrm{in}) \quad a(x).E \xrightarrow{a(v)} E\{v/x\} \quad \text{if} \quad v \in D$$

$$\mathrm{R}(\mathrm{out}) \quad \overline{a}(e).E \xrightarrow{\overline{a}(v)} E \quad \text{if } \mathrm{Val}(e) = v$$

$$\mathrm{R}(\stackrel{\mathrm{def}}{=}) \quad \frac{P \xrightarrow{a} F}{E \xrightarrow{a} F} \; P \stackrel{\mathrm{def}}{=} E$$

$$\mathrm{R}(+) \quad \frac{E_1 + E_2 \xrightarrow{a} F}{E_1 \xrightarrow{a} F} \qquad \frac{E_1 + E_2 \xrightarrow{a} F}{E_2 \xrightarrow{a} F}$$

$$\mathrm{R}(|\,\mathrm{com}) \quad \frac{E \,|\, F \xrightarrow{\tau} E' \,|\, F'}{E \xrightarrow{a} E' \quad F \xrightarrow{\overline{a}} F'}$$

$$\mathrm{R}(|) \quad \frac{E \,|\, F \xrightarrow{a} E' \,|\, F}{E \xrightarrow{a} E'} \qquad \frac{E \,|\, F \xrightarrow{a} E \,|\, F'}{F \xrightarrow{a} F'}$$

$$\frac{E\backslash J \xrightarrow{a} F\backslash J}{E \xrightarrow{a} F} \; a \notin J \cup \overline{J}$$

Example: protocol that may lose messages

$$\begin{array}{lcl}
\texttt{Sender} & \stackrel{\mathrm{def}}{=} & \texttt{in}(x).\overline{\texttt{sm}}(x).\texttt{Send1}(x) \\
\texttt{Send1}(x) & \stackrel{\mathrm{def}}{=} & \texttt{ms}.\overline{\texttt{sm}}(x).\texttt{Send1}(x) + \texttt{ok}.\texttt{Sender} \\
\texttt{Medium} & \stackrel{\mathrm{def}}{=} & \texttt{sm}(y).\texttt{Med1}(y) \\
\texttt{Med1}(y) & \stackrel{\mathrm{def}}{=} & \overline{\texttt{mr}}(y).\texttt{Medium} + \tau.\overline{\texttt{ms}}.\texttt{Medium} \\
\texttt{Receiver} & \stackrel{\mathrm{def}}{=} & \texttt{mr}(x).\overline{\texttt{out}}(x).\overline{\texttt{ok}}.\texttt{Receiver} \\
 & & \\
\texttt{Protocol} & \equiv & (\texttt{Sender} \,|\, \texttt{Medium} \,|\, \texttt{Receiver})\backslash\{\texttt{sm}, \texttt{ms}, \texttt{mr}, \texttt{ok}\}
\end{array}$$

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- τ cannot be observed in this way

Observable transitions

$$\texttt{C} \stackrel{\text{def}}{=} \texttt{in}(x).\overline{\texttt{out}}(x).\overline{\texttt{ok}}.\texttt{C}$$
$$\texttt{U} \stackrel{\text{def}}{=} \texttt{write}(x).\overline{\texttt{in}}(x).\texttt{ok}.\texttt{U}$$

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What is difference between?

$$(\texttt{C} \mid \texttt{U})\backslash\{\texttt{in}, \texttt{ok}\}$$

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$E \stackrel{\varepsilon}{\Longrightarrow} F$ or $E \stackrel{a}{\Longrightarrow} F$ where $a \neq \tau$

$$\mathrm{R}(\stackrel{\varepsilon}{\Longrightarrow}) \quad E \stackrel{\varepsilon}{\Longrightarrow} E \qquad \frac{E \stackrel{\varepsilon}{\Longrightarrow} F}{E \stackrel{\tau}{\longrightarrow} E' \quad E' \stackrel{\varepsilon}{\Longrightarrow} F}$$

$$\mathrm{R}(\stackrel{a}{\Longrightarrow}) \quad \frac{E \stackrel{a}{\Longrightarrow} F}{E \stackrel{\varepsilon}{\Longrightarrow} E' \quad E' \stackrel{a}{\longrightarrow} F' \quad F' \stackrel{\varepsilon}{\Longrightarrow} F}$$

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4. Draw the observable graph for $\texttt{Peterson}$