Verilog Size Checking

Context of Expressions

- Set of operands: $\mathcal{O}$.
- Set of contexts identifiers: $\mathcal{C} \simeq \mathbb{N}$.
- A context $q \subseteq \mathcal{Q}$ with $\mathcal{Q} \coloneqq \left\{ \underbrace{\mathrm{A}\, s}_{\text{Atom}} \mid s \in \mathbb{N} \right\} \sqcup \left\{ \underbrace{\mathrm{D}\, c}_{\text{Dependency}} \mid c \in \mathcal{C} \right\}$.
- $\Pi : \mathcal{C} \to 2^{\mathcal{Q}}$ a mapping context identifiers to their set.
- $e \in \mathcal{E}$, with $\mathcal{E}$ the set of expressions,
- $c \in \mathcal{C}$, a context identifier.
- Φ compute the size of a lvalue.

Base case

$$\frac{\Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, s\} \qquad s \coloneqq \Gamma(o) \qquad o \in \mathcal{O}}{\Pi \vdash o : c}$$

Operators

$$\oplus \in \{\texttt{+}, \texttt{-}, \texttt{*}, \texttt{/}, \texttt{\%}, \texttt{\&}, \texttt{|}, \texttt{\^{}}, \texttt{\^{}\~{}}, \texttt{\~{}\^{}}\} \qquad \frac{\Pi \vdash a : c \qquad \Pi \vdash b : c}{\Pi \vdash a \oplus b : c}$$

$$\oplus \in \{\texttt{+}, \texttt{-}, \texttt{++}, \texttt{--}, \texttt{\~{}}\} \qquad \frac{\Pi \vdash e : c}{\Pi \vdash \oplus e : c}$$

$$\oplus \in \{\texttt{++}, \texttt{--}\} \qquad \frac{\Pi \vdash e : c}{\Pi \vdash e \oplus : c}$$

$$\oplus \in \{\texttt{\$signed}, \texttt{\$unsigned}, \texttt{signed'}, \texttt{unsigned'}\} \qquad \frac{\Pi[c'] \coloneqq \{\} \qquad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{D}\, c'\} \qquad \Pi \vdash e : c'}{\Pi \vdash \oplus (e) : c}$$

$$\oplus \in \{\texttt{===}, \texttt{!==}, \texttt{==?}, \texttt{!=?}, \texttt{==}, \texttt{!=}, \texttt{>}, \texttt{>=}, \texttt{<}, \texttt{<=}\} \qquad \frac{\Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, 1\} \qquad \Pi[c'] \coloneqq \{\} \qquad \Pi \vdash a : c' \qquad \Pi \vdash b : c'}{\Pi \vdash a \oplus b : c}$$

$$\oplus \in \{\texttt{\&\&}, \texttt{||}, \texttt{->}, \texttt{<->}\} \qquad \frac{\Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, 1\} \qquad \Pi[c'] \coloneqq \{\} \qquad \Pi \vdash a : c' \qquad \Pi[c''] \coloneqq \{\} \qquad \Pi \vdash b : c''}{\Pi \vdash a \oplus b : c}$$

$$\oplus \in \{\texttt{\&}, \texttt{\~{}\&}, \texttt{|}, \texttt{\~{}|}, \texttt{\^{}}, \texttt{\~{}\^{}}, \texttt{\^{}\~{}}, \texttt{!}\} \qquad \frac{\Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, 1\} \qquad \Pi[c'] \coloneqq \{\} \qquad \Pi \vdash e : c'}{\Pi \vdash \oplus e : c}$$

$$\oplus \in \{\texttt{>>}, \texttt{<<}, \texttt{**}, \texttt{>>>}, \texttt{<<<}\} \qquad \frac{\Pi \vdash a : c \qquad \Pi[c'] \coloneqq \{\} \qquad \Pi \vdash b : c'}{\Pi \vdash a \oplus b : c}$$

$$\oplus \in \{\texttt{=}, \texttt{+=}, \texttt{-=}, \texttt{*=}, \texttt{/=}, \texttt{\%=}, \texttt{\&=}, \texttt{|=}, \texttt{\^{}=}\} \qquad \frac{s \coloneqq \Phi(l) \qquad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, s\} \qquad \Pi[c'] \coloneqq \{\mathrm{A}\, s\} \qquad \Pi \vdash b : c'}{\Pi \vdash l \oplus b : c}$$

$$\oplus \in \{\texttt{<<=}, \texttt{>>=}, \texttt{<<<=}, \texttt{>>>=}\} \qquad \frac{s \coloneqq \Phi(l) \qquad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, s\} \qquad \Pi[c'] \coloneqq \{\} \qquad \Pi \vdash b : c'}{\Pi \vdash l \oplus b : c}$$

$$\frac{\Pi[c'] \coloneqq \{\} \quad \Pi \vdash e : c' \quad \Pi \vdash a : c \quad \Pi \vdash b : c}{\Pi \vdash e\texttt{?}a\texttt{:}b : c}$$

$$\frac{\Pi[c_1] \coloneqq \{\} \quad \Pi \vdash e_1 : c_1 \quad \ldots \quad \Pi[c_k] \coloneqq \{\} \quad \Pi \vdash e_k : c_k \quad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{D}\, c_1, \ldots, \mathrm{D}\, c_k\}}{\Pi \vdash \texttt{\{}e_1, \ldots, e_k\texttt{\}} : c}$$

$$\frac{i \in \mathbb{N} \quad \Pi[c_1] \coloneqq \{\} \quad \Pi \vdash e_1 : c_1 \quad \ldots \quad \Pi[c_k] \coloneqq \{\} \quad \Pi \vdash e_k : c_k \quad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{D}\, c_1, \ldots, \mathrm{D}\, c_k\}}{\Pi \vdash \texttt{\{}i\texttt{\{}e_1, \ldots, e_k\texttt{\}\}} : c}$$

$$\frac{\Pi[c'] \coloneqq \{\} \quad \Pi \vdash a : c' \quad \Pi \vdash e_1 : c' \quad \ldots \quad \Pi \vdash e_k : c' \quad \Pi[c] \coloneqq \Pi[c] \cup \{\mathrm{A}\, 1\}}{\Pi \vdash a \texttt{ inside \{}e_1, \ldots, e_k\texttt{\}} : c}$$