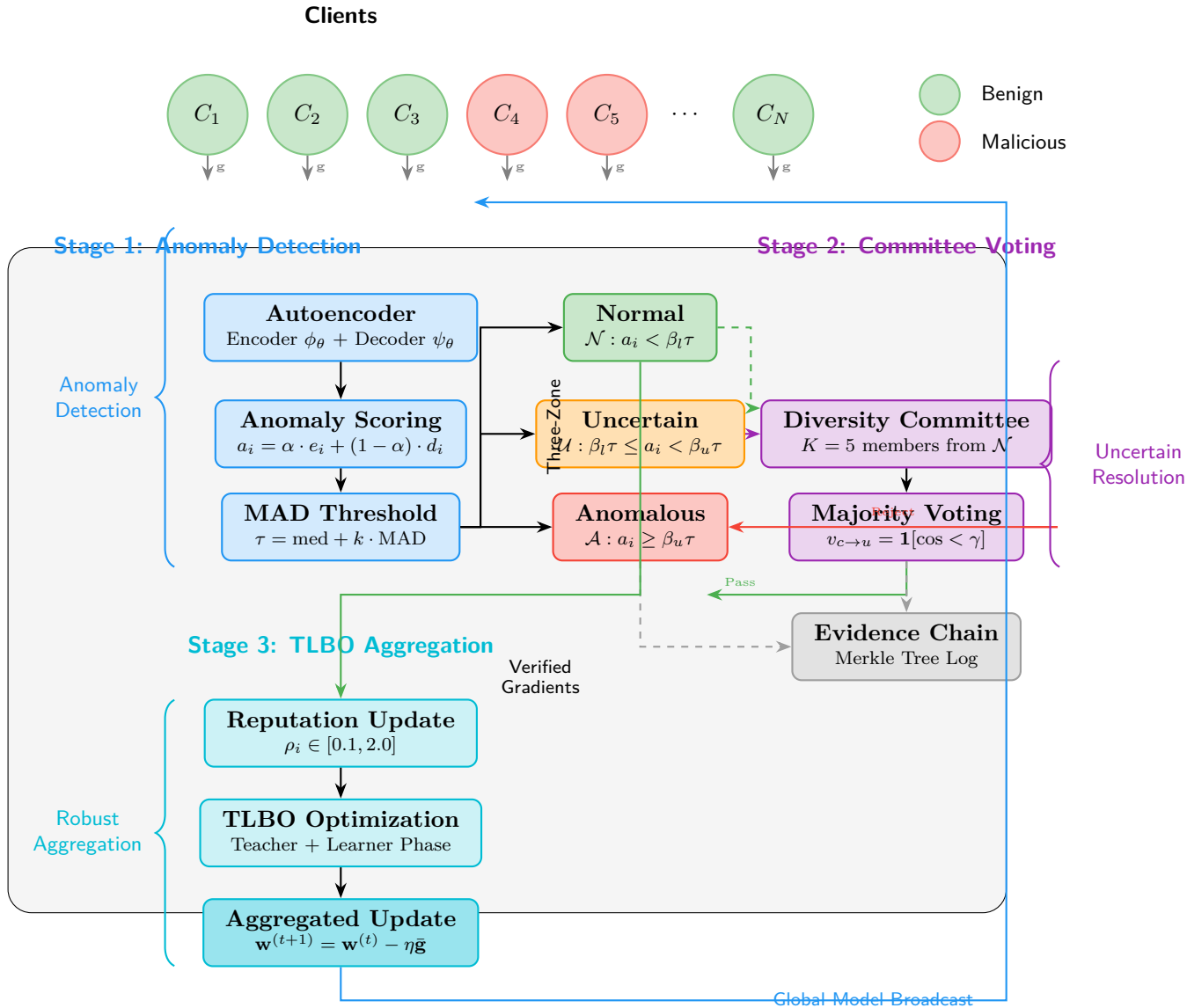
Clients
C_1
C_2
C_3
C_4
C_5
$\cdots$
C_N
g
Benign
Malicious
Stage 1: Anomaly Detection
Stage 2: Committee Voting
Autoencoder
Encoder ϕ_θ + Decoder ψ_θ
Anomaly Scoring
$a_i = \alpha \cdot e_i + (1-\alpha) \cdot d_i$
MAD Threshold
$\tau = \text{med} + k \cdot \text{MAD}$
Anomaly Detection
Normal
$\mathcal{N} : a_i < \beta_l \tau$
Three-Zone
Uncertain
$\mathcal{U} : \beta_l \tau \leq a_i < \beta_u \tau$
Anomalous
$\mathcal{A} : a_i \geq \beta_u \tau$
Diversity Committee
$K = 5$ members from $\mathcal{N}$
Majority Voting
$v_{c \to u} = \mathbf{1}[\cos < \gamma]$
Reject
Pass
Uncertain Resolution
Evidence Chain
Merkle Tree Log
Stage 3: TLBO Aggregation
Verified Gradients
Reputation Update
$\rho_i \in [0.1, 2.0]$
TLBO Optimization
Teacher + Learner Phase
Aggregated Update
$\mathbf{w}^{(t+1)} = \mathbf{w}^{(t)} - \eta \bar{\mathbf{g}}$
Robust Aggregation
Global Model Broadcast