Figure 3: BITW Controller System Architecture
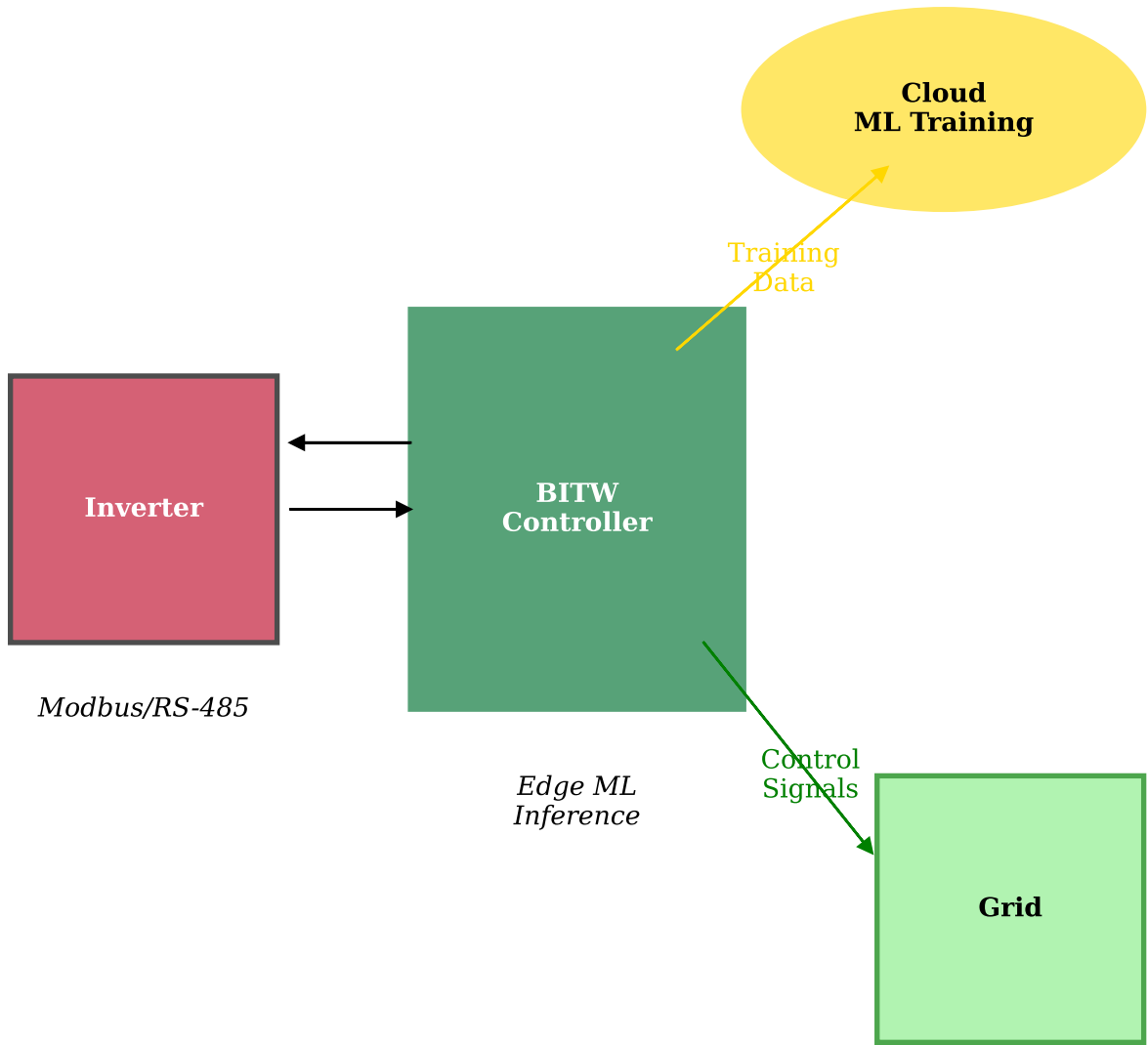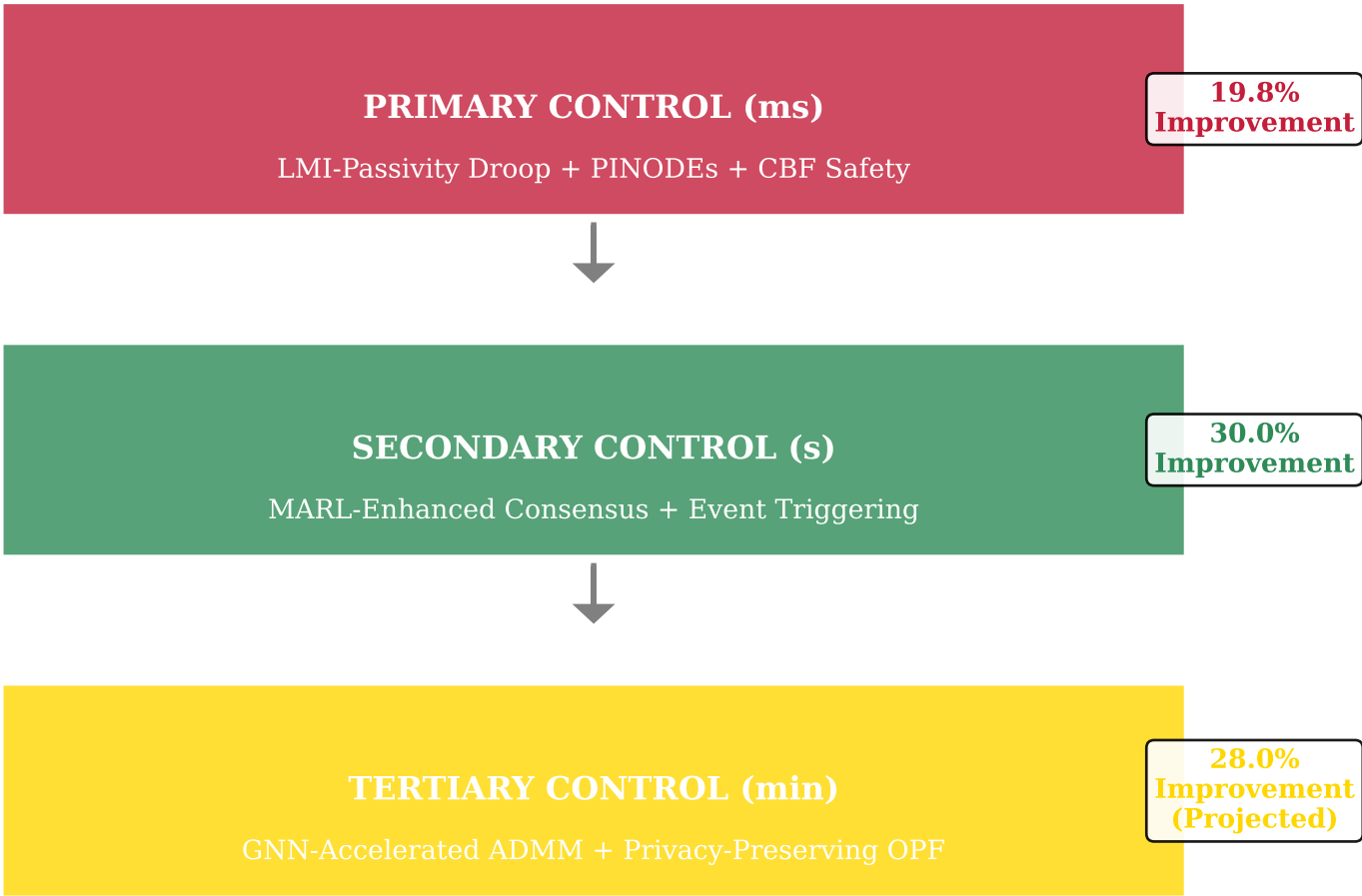
A) BITW Controller Architecture

B) Hierarchical Control Architecture

Cloud
ML Training

Training
Data

Inverter

BITW
Controller

Modbus/RS-485

Edge ML
Inference

Control
Signals

Grid

PRIMARY CONTROL (ms)

LMI-Passivity Droop + PINODEs + CBF Safety

**19.8%
Improvement**

SECONDARY CONTROL (s)

MARL-Enhanced Consensus + Event Triggering

**30.0%
Improvement**

TERTIARY CONTROL (min)

GNN-Accelerated ADMM + Privacy-Preserving OPF

**28.0%
Improvement
(Projected)**

↓ *82% Cost Reduction* • ↑ *30% Faster Convergence (36% fewer iterations)* • ↑ *150 ms Delay Tolerance*