

Use of Hardware-in-the Loop Traffic Simulation in a Virtual Environment

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Outline

- Introduction to HILS
- Brief History of CIDs for HILS
- ATACid Technology
 - Functionality
 - Hardware components
 - Software components
 - Simulation interface



Introduction

- **Traffic Simulation – mimic the behavior of a transportation system (roadway, vehicles, pedestrians, traffic control devices)**
- **Hardware-in-the-loop simulation (HILS) – replaces emulated traffic control logic with actual traffic controllers**



Purpose of HILS

- **Traffic simulation program limitations**
 - Priority/preemption strategies
 - Traffic responsive or adaptive control logic
 - Vendor specific features
- **Education and training**
 - Traffic engineers and technicians
 - Academia



Components of HILS

- Traffic simulation software program
- Traffic signal controller
- Hardware connects simulation program and controller
- Software to interpret, format, and send information between devices

Controller Interface Device (CID)

CID Development

CID (mid-90's)

Purdue University,
FHWA, ITT Systems

NEMA TS-1



CID II (2002)

NIATT (University of Idaho),
Purdue University, FHWA,
and McCain Traffic Supply, Inc.

NEMA TS-1, Type 170 & 2070

CID Development

SimTraffic CI (2005)

Trafficware Corp.

NEMA TS-2, 2070,
ATC



ATACid (2005)

ATAC (North Dakota State University)

NEMA TS-2, 2070, ATC

Functionality

- **NEMA TS 2 compliant traffic controllers**
- **Various traffic simulation models and controller test programs**
- **Ethernet connectivity**
 - **Easy of use**
 - **Share resources**



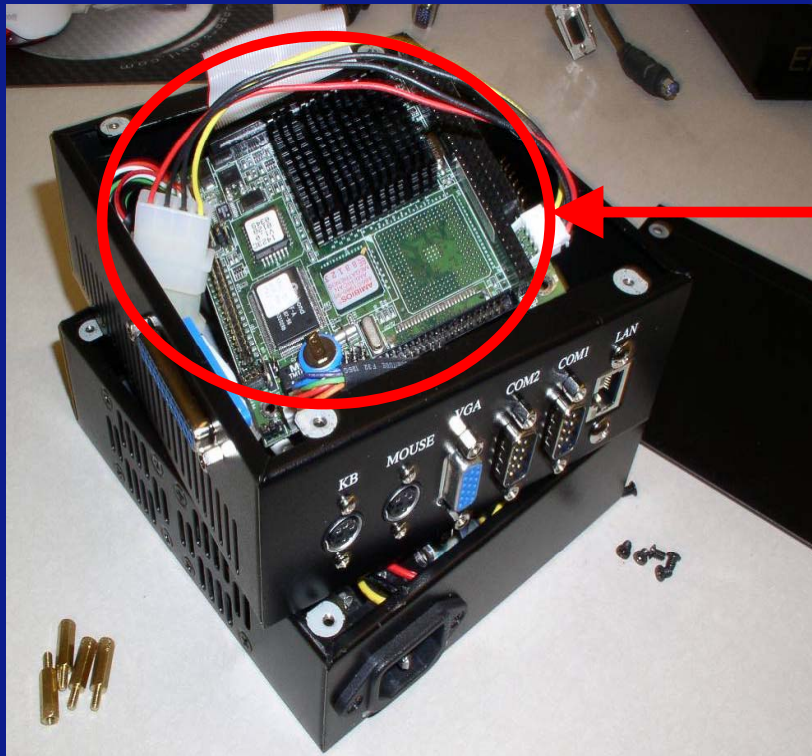
Hardware Components

- **PC/104 platform (embedded system)**
- **EIA-485 port with SDLC protocol for communicating with traffic controller**
- **Ethernet port for communicating with the host PC**
- **RS-232 port for performing the Ethernet configuration**



Hardware Components

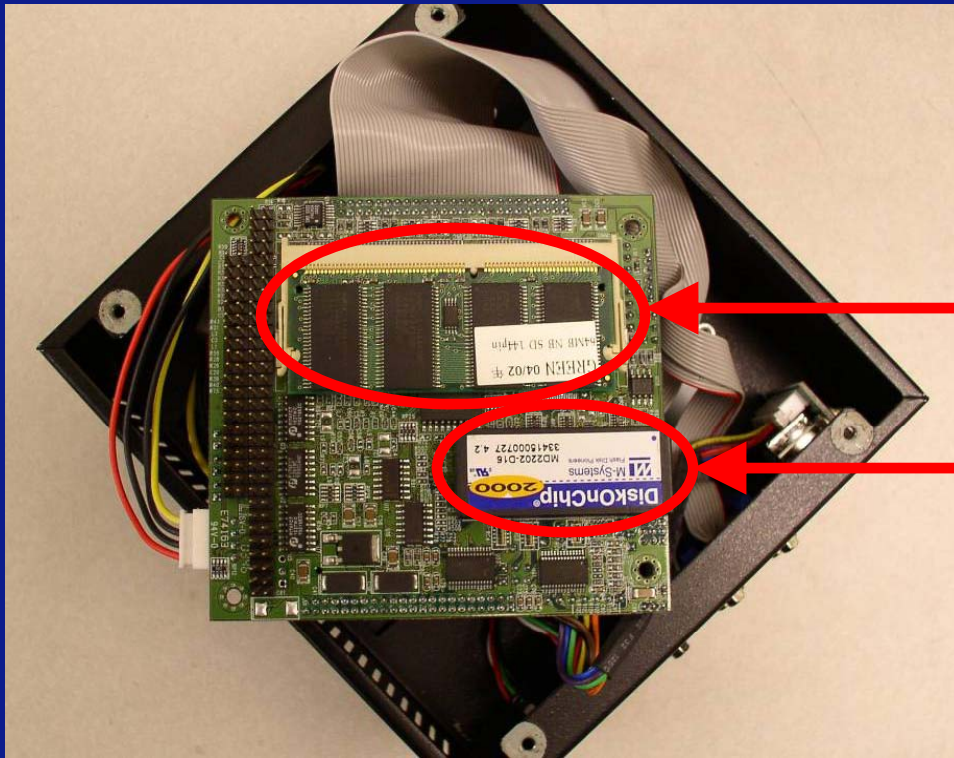
Top View of Embedded System



Top view of
motherboard

Hardware Components

Bottom View of Motherboard

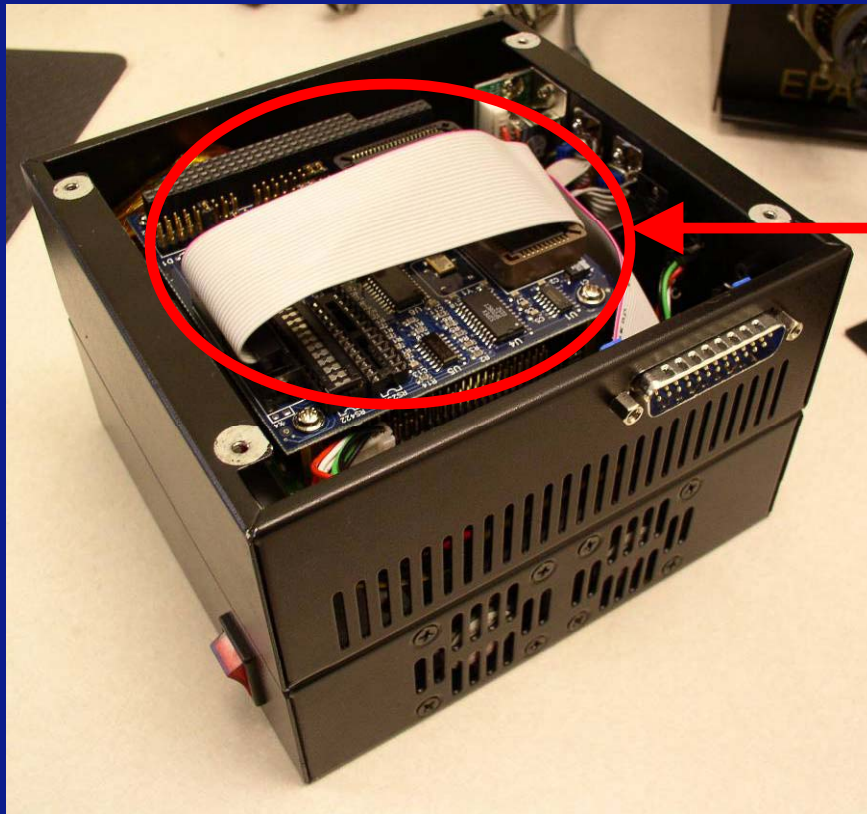


64MB RAM

32MB DOC

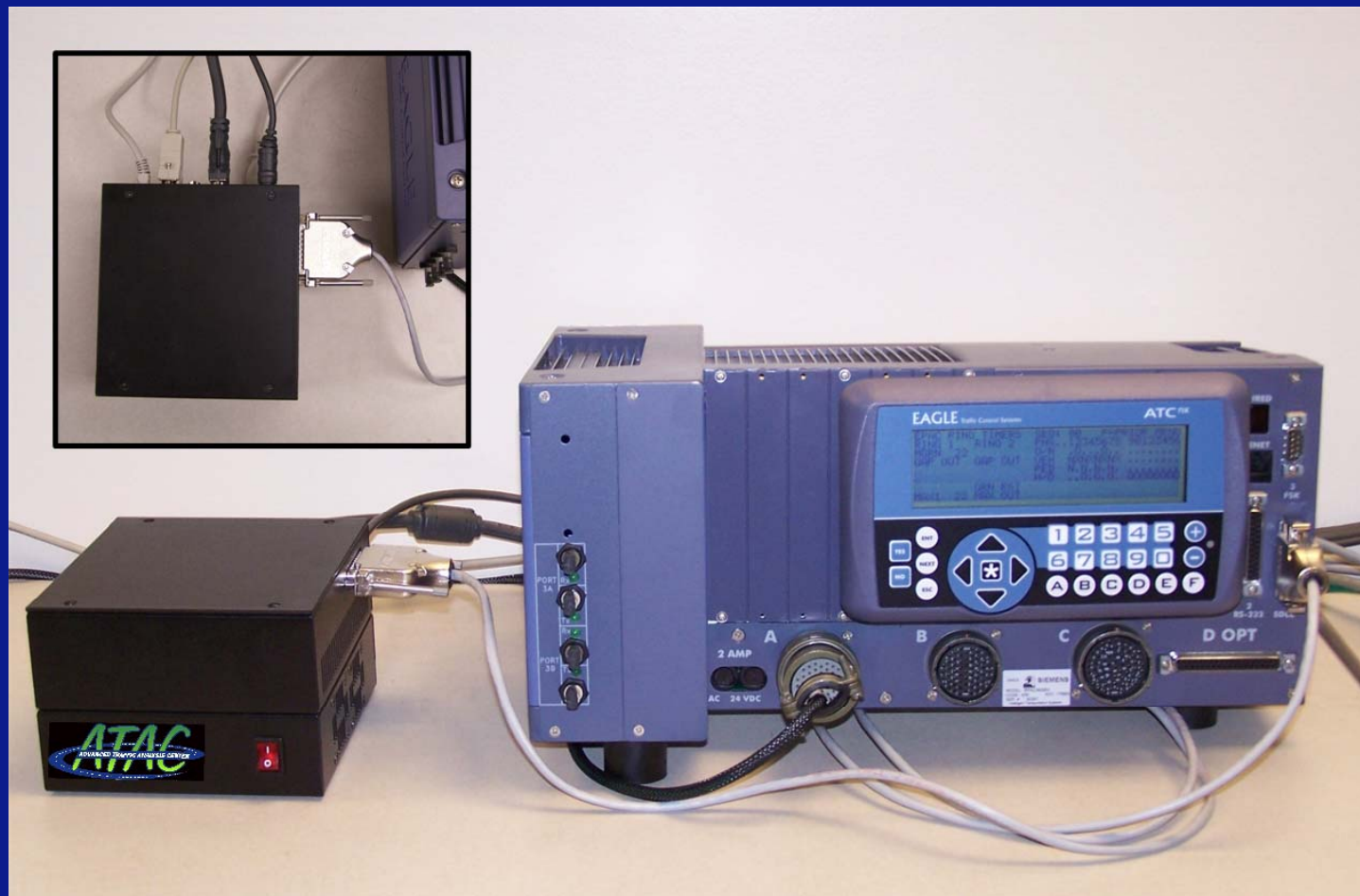
Hardware Components

Top View of Embedded System



**EIA-485 SDLC
card added to
motherboard**

Assembled and Functioning



Software Components

- **FreeDOS OS**
 - Open source, actively supported, and free
- **SDLC serial card**
 - Custom drivers were developed
- **Software programs**
 - CIDserv, CIDlink, and SerUpdt



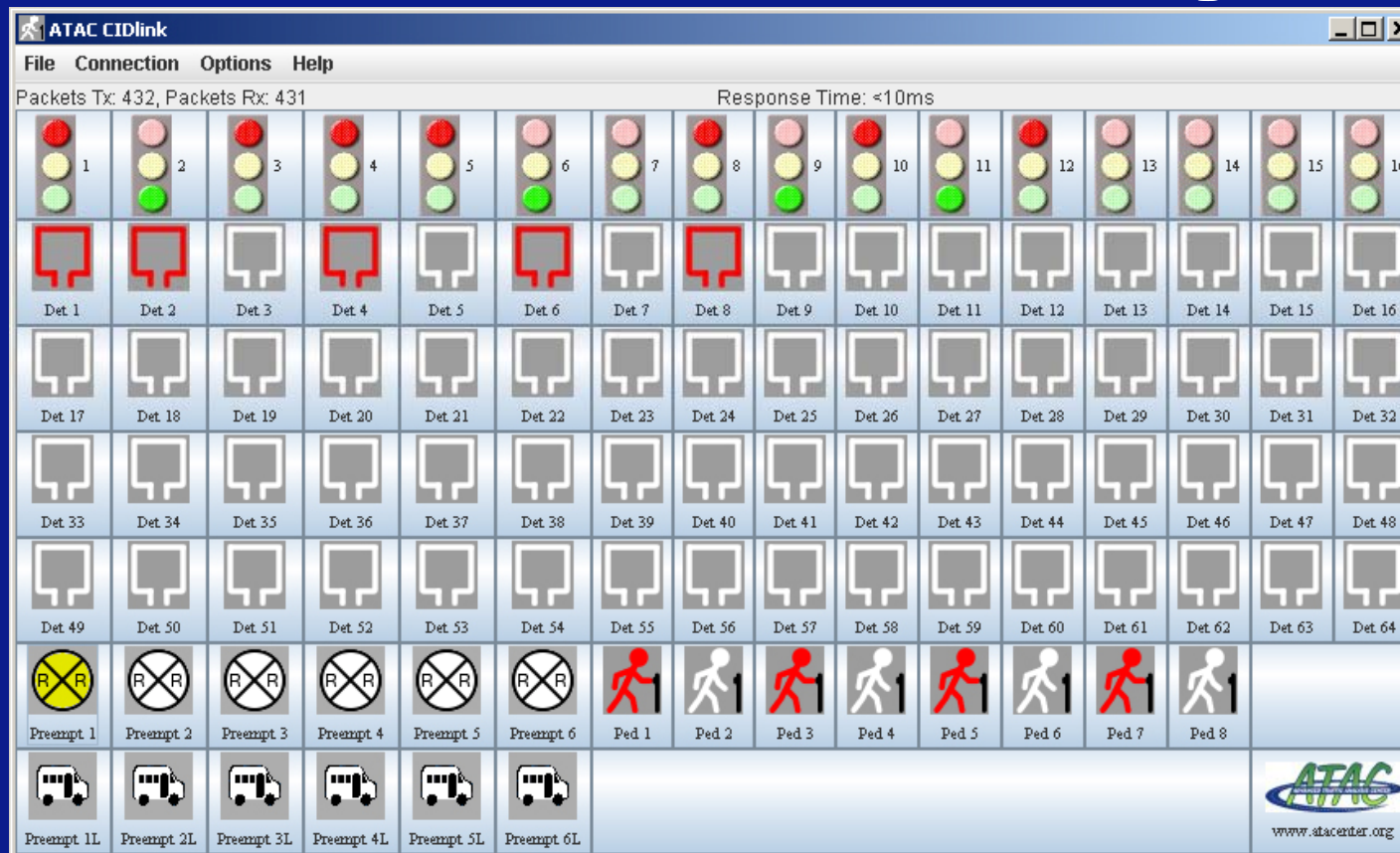
CIDserv software

- **Runs continuously on the CID**
- **Prevents “Diagnostic Flash Mode”**
- **Formats and exchanges information between computer and traffic controller**



CIDlink Software

- Receives and transmits data
- Used for verification and testing



CIDlink Software

- **“Detector Test” feature to test vehicle, pedestrian, and priority/ preemption detectors**
- **Detector calls are sent to the traffic controller at the appropriate rate duration**



Detector Test

Enter values for Ø 1

V.p.h:

Approach Speed (mph):

Vehicle Length (ft):

Detector Length (ft):

Start Time (sec):

ATAC CIDlink

Select Vehicle Phases for Each Approach (use movement pulldowns)

Select Pedestrian Phases

Select Preempts/Priorities

Test Duration: (mins)

Help / Info

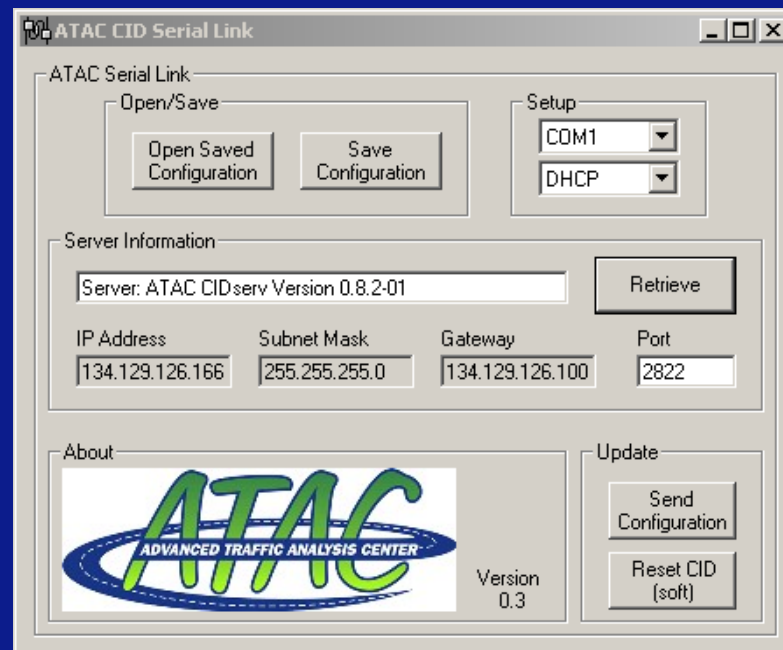
Note: This program operates at a 100 milliseconds (ms) packet rate. Therefore, the detector durations will be rounded up to the nearest 100 ms.

Phase #	V.P.H	Approach Speed (mph)	Vehicle Length (ft)	Detector Length (ft)	Call Rate (sec)	Call Duration (ms)	Start Time (sec)
1	200	30	20	6	18.0	590	0
2	450	30	20	6	8.0	590	0
3	700	30	20	6	5.143	590	0
4	950	30	20	6	3.789	590	0
5	1200	30	20	6	3.0	590	0
6	1450	30	20	6	2.483	590	0
7	1700	30	20	6	2.118	590	0
8	1950	30	20	6	1.846	590	0



SerUpdt CID Configuration Utility

- Set and retrieve the CID's IP network information
 - RS-232 serial port



Ethernet Connectivity

- **CIDlink and simulation interface communicate to each CID using an IP**
- **PC is not physically connected to CID/controller combinations**
- **Share CID/controller combinations from various geographical locations**



Simulation Interface

- Interfaces with the VISSIM simulation model (PTV AG)
- Forthcoming interfaces:
 - TSIS/CORSIM 6.0
 - Citilab's Cube Dynasim

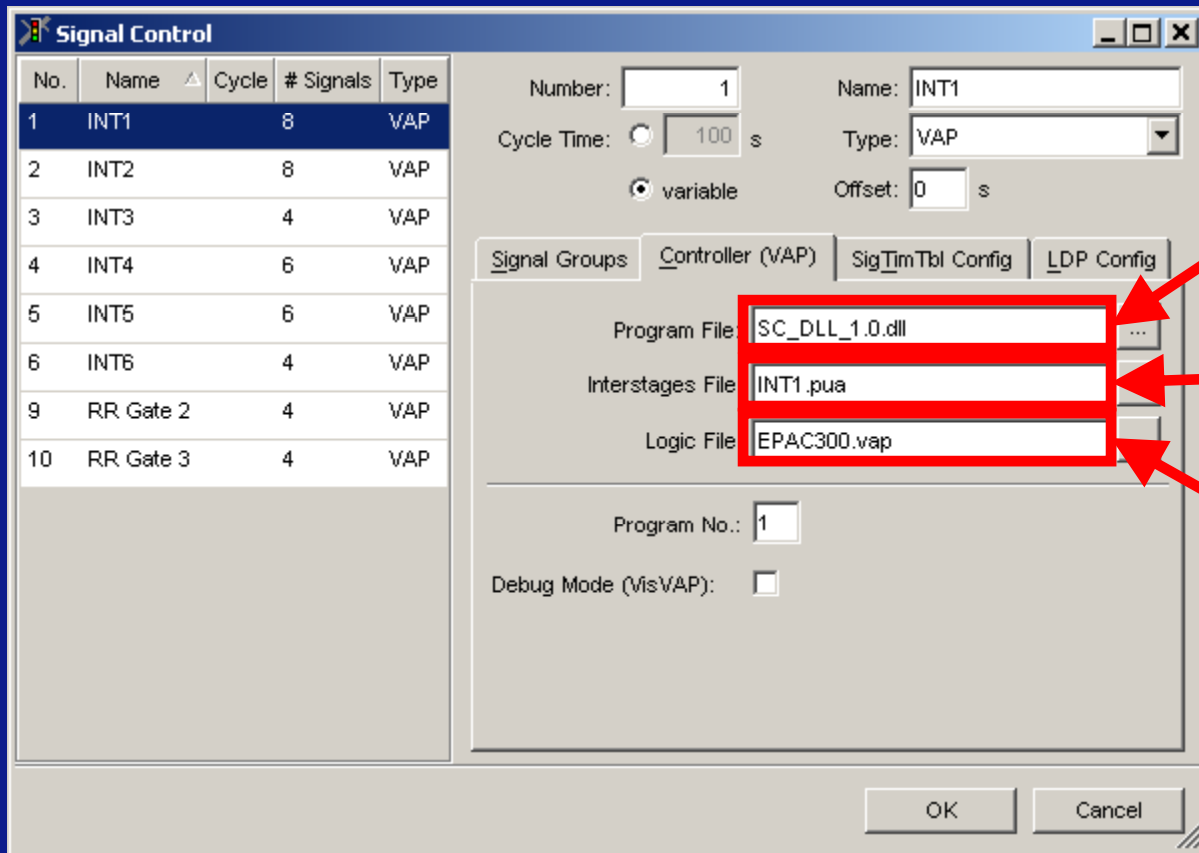


VISSIM Interface

- **Dynamic link library (DLL) runs within VISSIM to process detector and signal data**
- **Configuration file associates VISSIM intersection control to appropriate CID**
- **1 instance of the DLL is created and communicates with all CIDs**



VISSIM Interface



Control program used by VISSIM

Network info of ATACid

Maps simulation phases to controller phases

Traffic Controller Configuration

- **NEMA TS 2 controller configuration**
 - **Enable Port 1 addresses (T&F BIU devices, Detector BIU devices, and the MMU)**



HILS Operation

VISSIM sends its detector calls to CID 10 X per sec.

CIDserv
Formats detector call data into frames
Formats signal states into frames
CID
Forwards detector frames to controller
Forwards signal states to VISSIM

Responds to VISSIM's detector calls
Relays signal states to CID

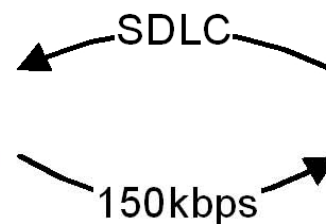
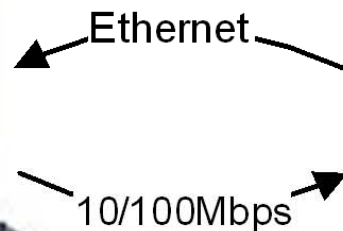
VISSIM Simulation



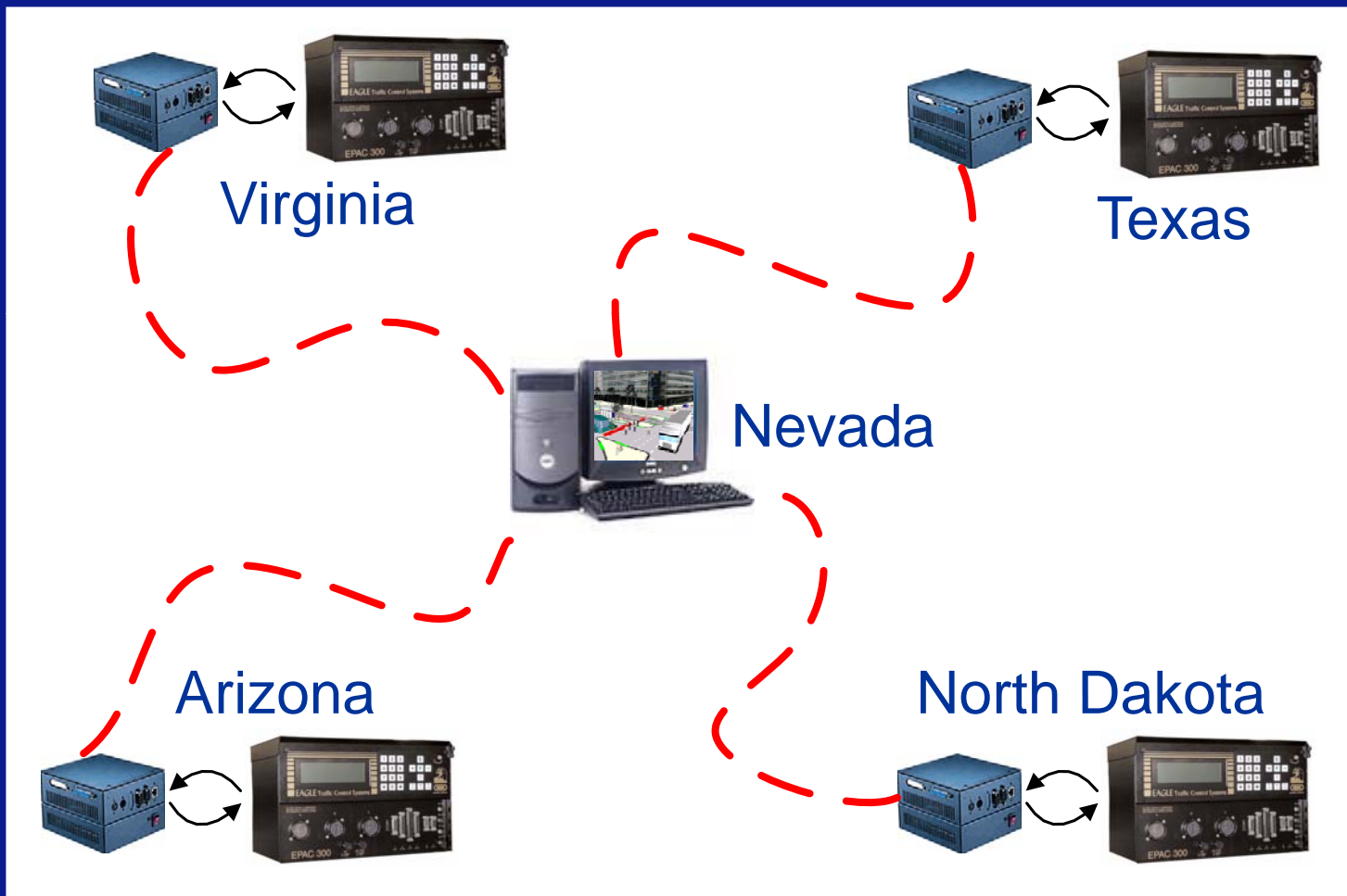
ATACid



Traffic Controller



Virtual Traffic Laboratory



Summary

- **ATACid attributes**
 - **Off-the-shelf technology**
 - **Cost effective**
 - **Small in size**
 - **EIA-485 port using SDLC**
 - **Ethernet (virtual environment)**



For More Information:

<http://www.atacenter.org/cid/>

