Centralized Remedial Action Scheme

Presented by:

Patricia Arons/Jun Wen – SCE

Herbert Falk - SISCO

Using Emerging Telecommunication, Protection Technologies, and OSIsoft PI System to create a high performance wide area control system

Empowering Business in Real Time

PI Infrastructure for the Enterprise

To be covered

- What makes this project “special”
- Overview of the project
- Where is the benefit in using the PI System
- Other enhancements being discussed
- Interesting technical tidbits

What makes the project “special”

- Wider scope of review
- Education
- Give information to the industry.
- Talk about benefits.
- Have authoritative test results.

- Prove that existing technology can come close
- Education
- Incremental technological developments.
- Project plan with multiple decision gates.
- Have a leader that “herds the cats”.
- Have a team approach.
- No stupid questions.

- Centralize supervisory control/automation
- System wide decision optimization
- Use of communications
- Design and use of natural testing
- Use PI for SOE
- Make PI integral in testing/ problem correction cycle
- Don’t be afraid to ask for help

- Distributed Automation projects
- Regional/cell based decisions.
- Hardware intensive
- Intermittent manual testing
- No SOE capture
- “Can’t tell why it didn’t work.”
- 80-100 msec control

Teamwork: Reaching the finish line

Enernex

GE

OMICRON

OSIsoft

SCE

SEL

SISCO

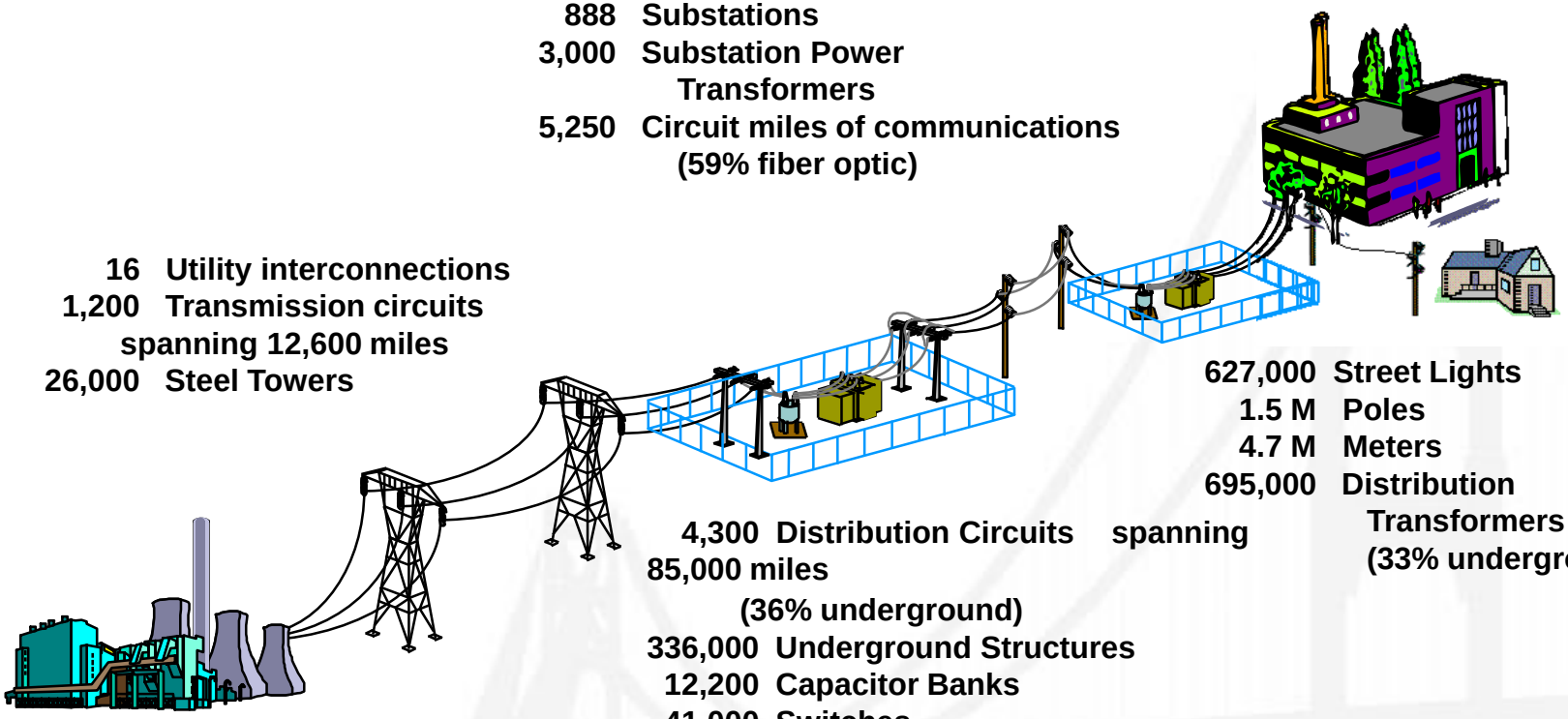
The project

SCE T&D Assets

Generation **Transmission & Subtransmission** **Distribution** **Customer**

888 Substations
3,000 Substation Power Transformers
5,250 Circuit miles of communications (59% fiber optic)

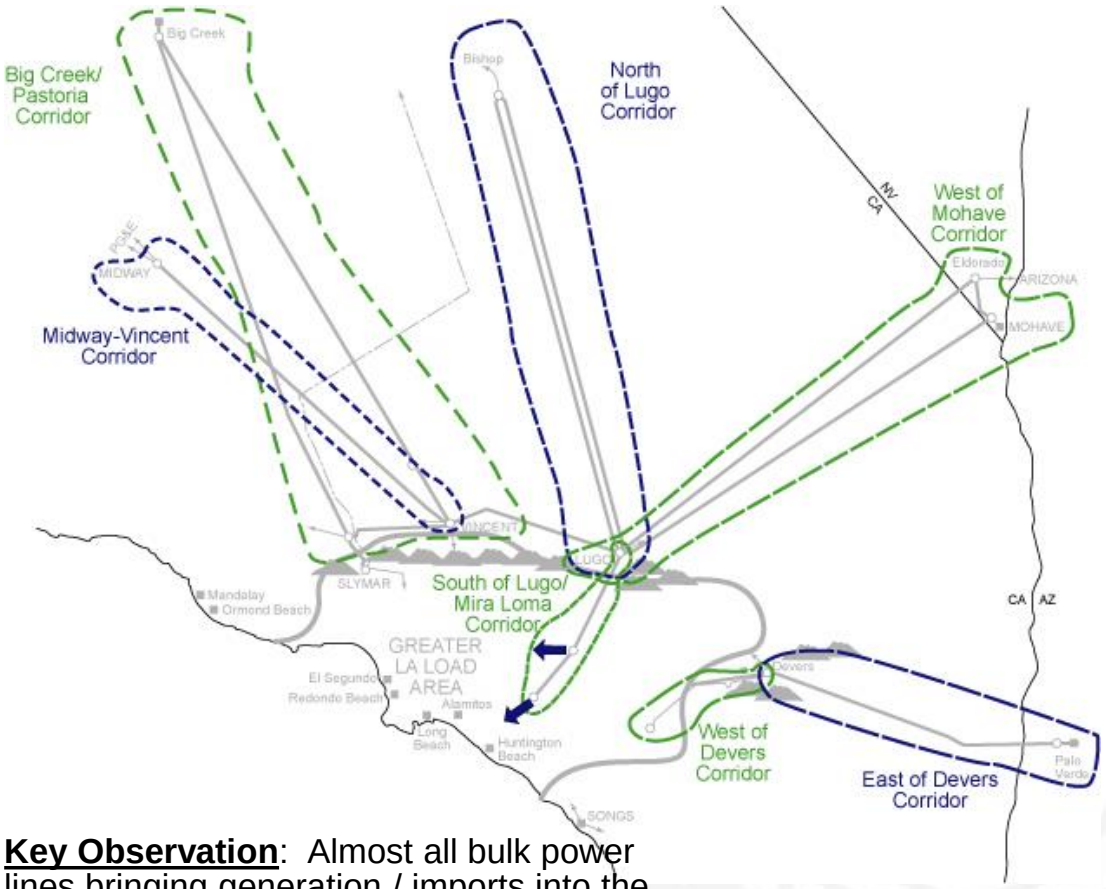
16 Utility interconnections
1,200 Transmission circuits spanning 12,600 miles
26,000 Steel Towers



627,000 Street Lights
1.5 M Poles
4.7 M Meters
695,000 Distribution Transformers (33% underground)

4,300 Distribution Circuits spanning 85,000 miles (36% underground)
336,000 Underground Structures
12,200 Capacitor Banks
41,000 Switches
39,300 Relays
11,500 Circuit Breakers
1,017 Automatic Reclosers

SCE Transmission Corridors and Proliferating RAS Schemes



Key Observation: Almost all bulk power lines bringing generation / imports into the greater Los Angeles basin load area are being monitored for contingencies and flow levels, and controlled by local RAS schemes.

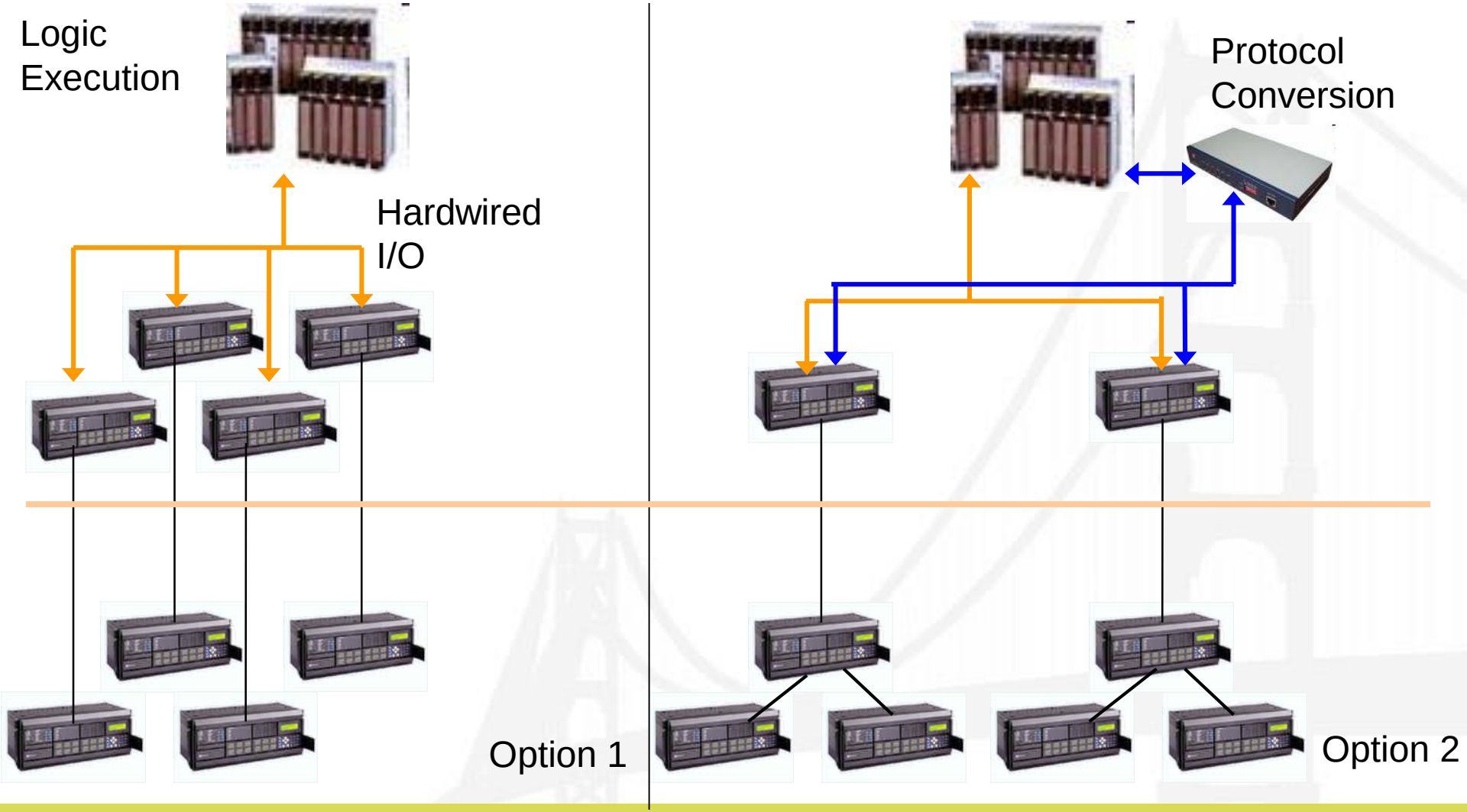
- **Existing RAS = 18 on all transmission corridors**
- **Expected potential new RAS (2009-2011) = 50-60**
- **RAS impacted transmission**
  - Generation tripping
  - Load shedding

Voltage	Miles of Transmission Circuits	
	Total Miles	RAS Monitored (%)
500 kV	**1,183**	**1,069 (90%)**
230 kV	**3,574**	**1,181 (33%)**
115 kV	**1,846**	**350 (19%)**
All	**6,603**	**2,600 (40%))**

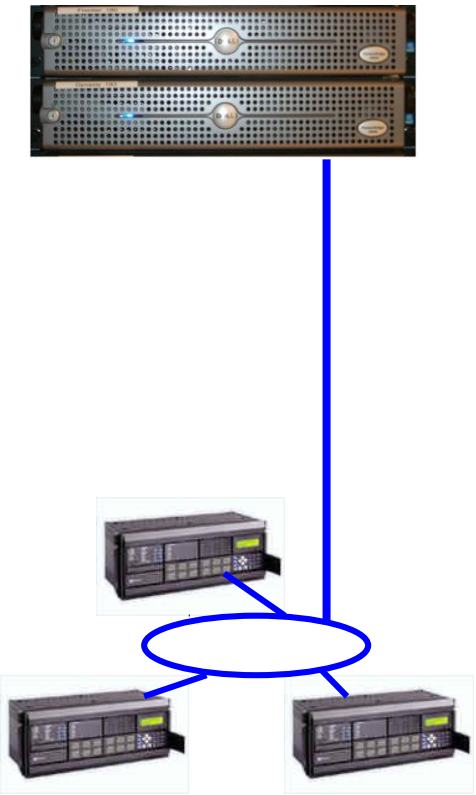
Project Objectives

- **Solves today's RAS problems:**
  - **ONE SIZE FITS ALL:** Inability to size a RAS driven mitigation targets based on dynamic assessment of generation tripping / load shedding requirements
  - **OVERLAP:** Same Generation / Load subject to interruption for numerous reasons controlled by different RAS' and other reliable and safe operational requirements
  - **TIME LOSS:** Excessive travel time by engineering and field staff to maintain the local RAS schemes at numerous sites
  - **CONTROLLER TECHNOLOGY LIMITATIONS:** Inability to represent greater than 24 contingencies per controller
- **Adopts Emerging Technologies to achieve higher performance**
  - IEC61850 GOOSE Standard
  - OSIsoft PI System
- **Save money, decrease energy usage, increase testability and process improvement, and achieve higher morale**

How “C-RAS/SPS” is typically done



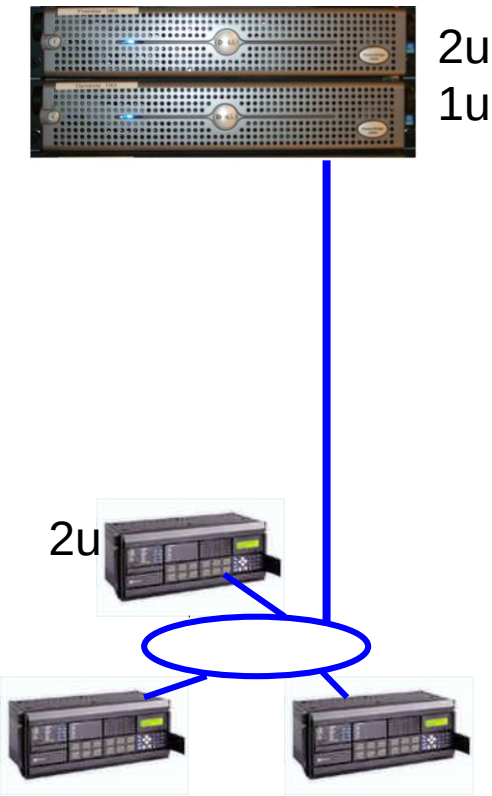
SCE C-RAS and comparison



For 80 Substations (5 devices per substation per system):

	Option 1	Option 2	SCE	Estimated Savings
# substation relays				
A system	400	480	400	$ 0-320K
B system	400	480	400	$ 0-320K
# control center relays				
A system	400	80	0	$ 320K – 1.6M
B system	400	80	0	$ 320K – 1.6M
# logic processors/scheme				
A system	1	1/10	1/80	$ 70K - 800K
B system	1	1/10	1/80	$ 70K - 800K
# history captured				
	no	no	**yes**	

SCE – number of 19” racks required



	option 1	option 2	SCE
# racks			
A	40-80	20-40	2
B	40-80	20-40	2

Decreased floor space and lower requirements means not having to build two new control centers. **Savings = $20M-40M**

Less heat and less computers is a more energy efficient solution.

Other benefits/observations

- Decreases overall telecom maintenance costs.
- SCE has fiber to most of its substations, need to "light it up".
- Easier to maintain and diagnose.
- Decreases time to deployment (from 2-3 years to 6-months*)
  - Morale benefits and large savings.

More benefits

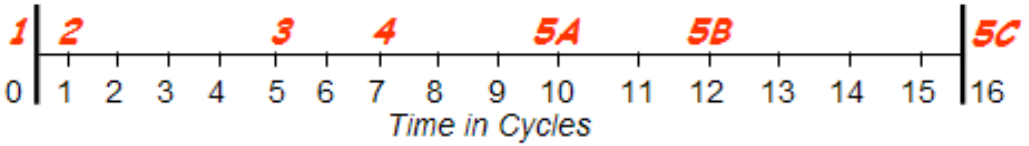
- Use of IEC 61850 GOOSE allows for equipment from different manufacturers to be used within a single system.
  - Option 1 and Option 2 RAS schemes don't allow this.

Increased performance

- Option 1 and 2 have “local” performance of 20-30 msec.
- SCE pilot has an observed “local” performance of < 1 msec.

RAS Timeline

A RAS Case Simulation



1 cycle = 16.7 milliseconds

	Time	Operational Events
Step 1	@ 0 Cycle	3 Phase Fault on the Bus
Step 2	@ 1 Cycle	Relay Processing time for trip signal to CBs
Step 3	@ 5 Cycles	Open CBs for line/transformer out
Step 4	@ 7 Cycles	RAS Logic Processing for trip signal to CBs to trip generators
Step 5A	@ 10 Cycles	Open CBs associated with 12 generators (I Batch Mitigation)
Step 5B	@ 12 Cycles	Open CBs associated with 4 generators (II Batch Mitigation)
Step 5C	@ 16 Cycles	Open CBs associated with 2 generators (III Batch Mitigation)

Event Detection Fault Clearing: 5 Cycles

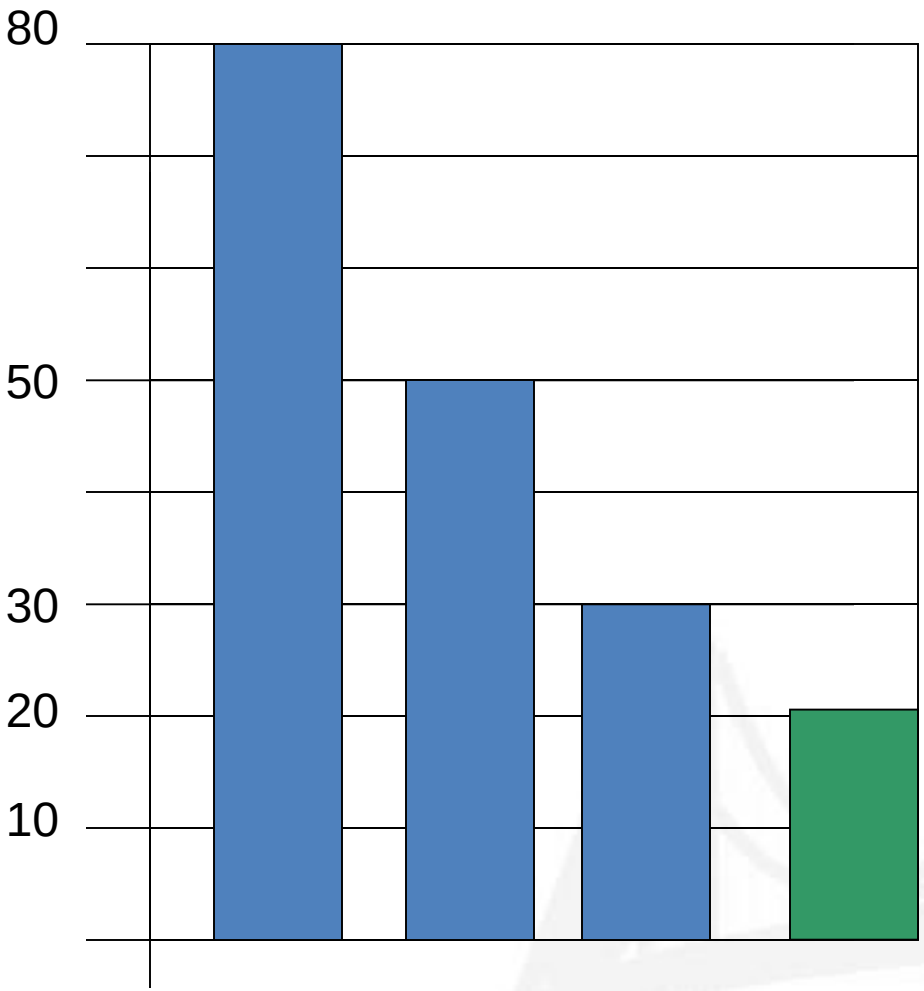
RAS Processing: 2 Cycles

Local Processing time

Mitigation Generation Tripping / Load Shedding: 9 Cycles

Total Elapsed Time: 16 Cycles

C-RAS Performance vs. Potential Savings



- Provides supervisory protection as needed by most RAS schemes

- Allows more complex algorithms to be created that provide a more optimal solution and less customer outages.

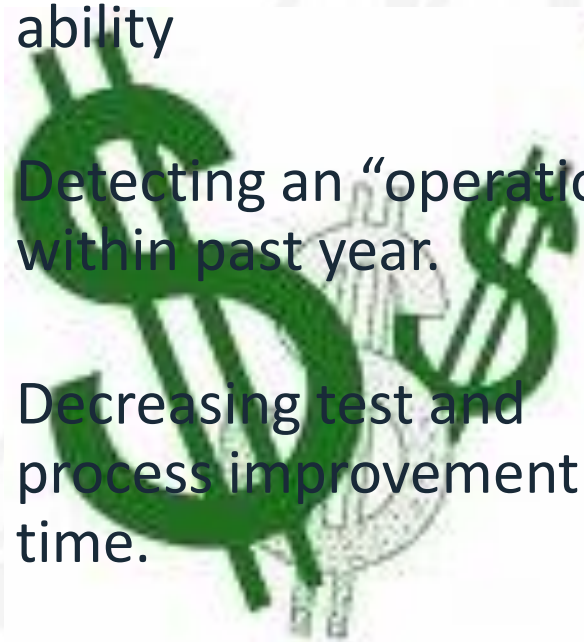
- Allows transmission lines to be loaded closer to the limits. Allows more low cost power to be imported.

- Performance of SCE system should allow deferral of generator builds. Increases system import capability by 5% (~800 MW).

The Benefits of PI

Project uses the PI System for:

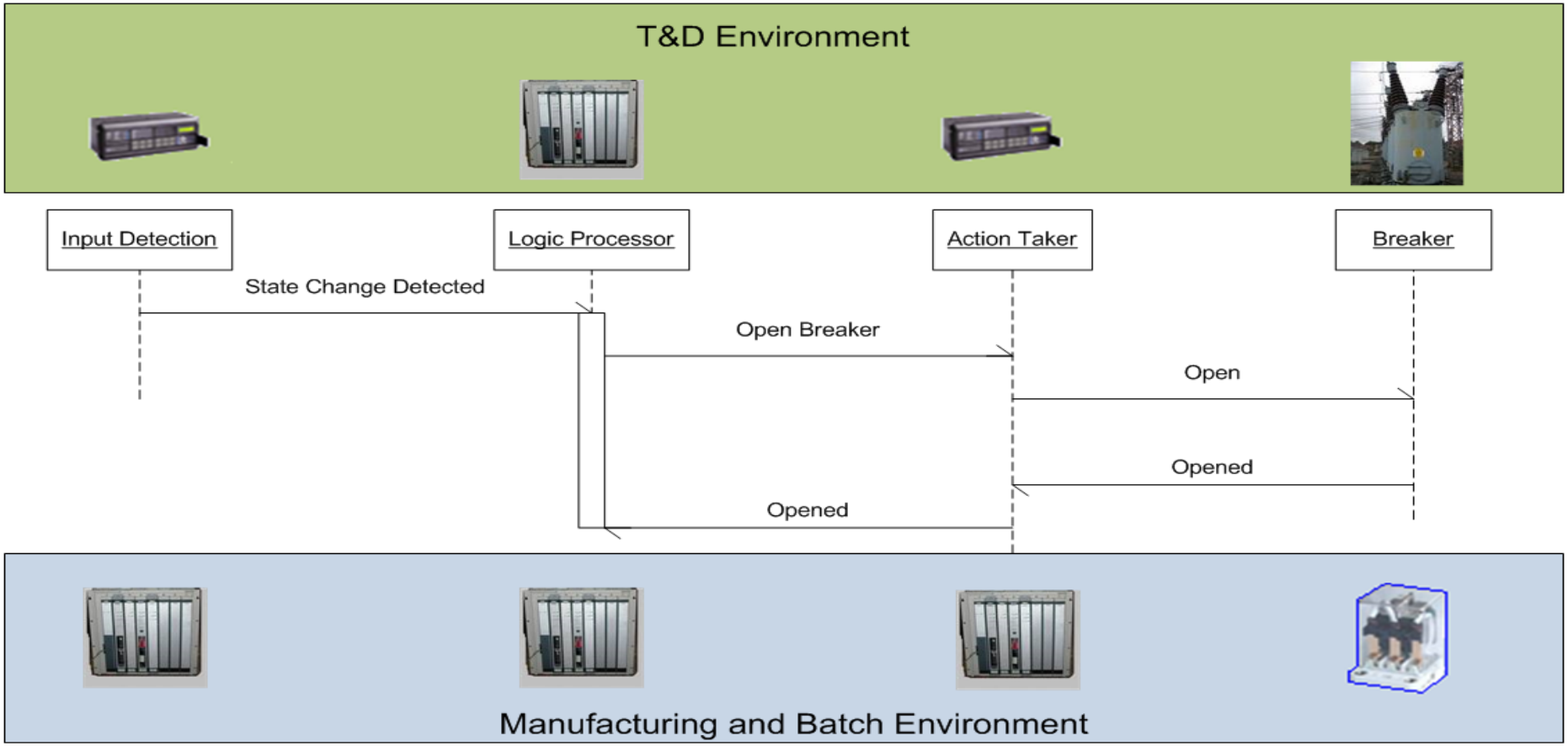
- Typical Uses
  - Archive/SOE
  - Visualization
  - Data Mining/Report Generation
  - Design Compliance checking
- Expanded use
  - System degradation and operation detection ability
  - Detecting an “operation” within past year.
  - Decreasing test and process improvement time.



Detecting an operation

- The Western Electricity Coordinating Council (WECC) requires one (1) end-to-end test/operation per year.
- Ability to avoid this “outage”/decrease in availability is key.
- Design of system even lowers the costs should an end-to-end test be required.

Typical Design of Automation Systems

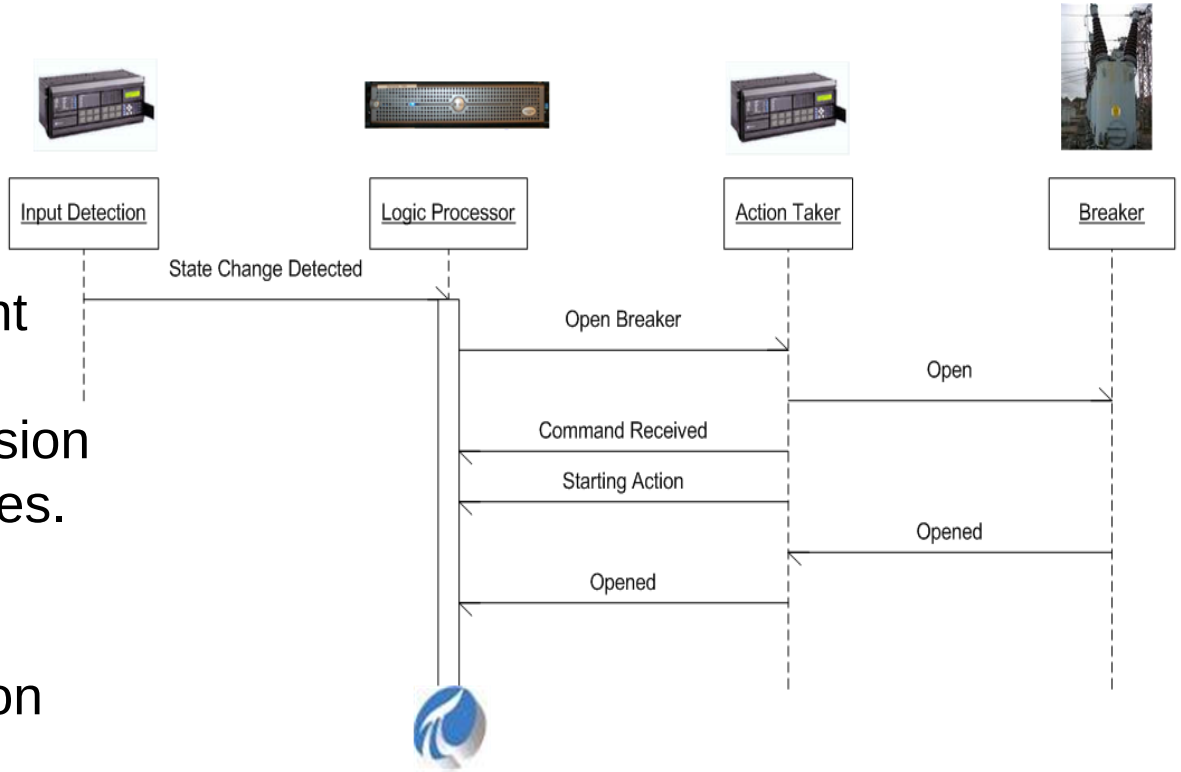


Logic processor has little or no historical storage capability
Several key process steps/timing are unknown

The SCE and natural testing approach

Now can track:

- Close loop performance
- Command to Acknowledgment
  - Determine/track transmission latencies and logic changes.
- Time of execution
  - Circuit breaker degradation can be detected.



Fallout of approach: Can data mine/report for the last true operation within one (1) year and determine if an end-to-end test is needed.

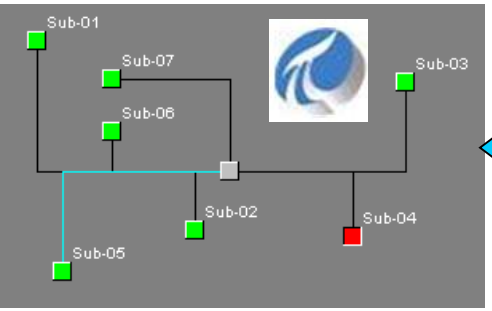
Decreasing process improvement time

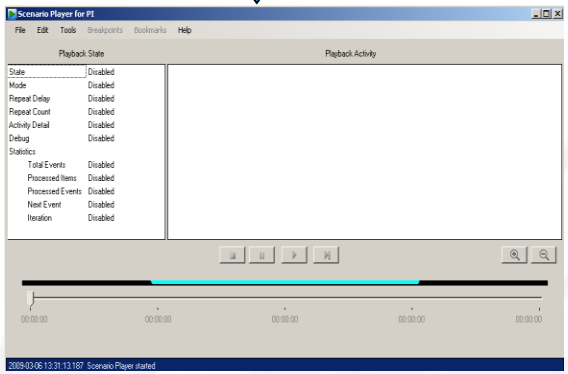
Detection

Logic

Mitigation

Event Extraction





Logic/Program Debug or Development Environment

Display Development and Training

What might be next

- Dynamic mitigation strategies
- Integration of PMU (Phasor Measurement Unit) measurements
  - Real-time phase difference calculation

Technical Tidbits

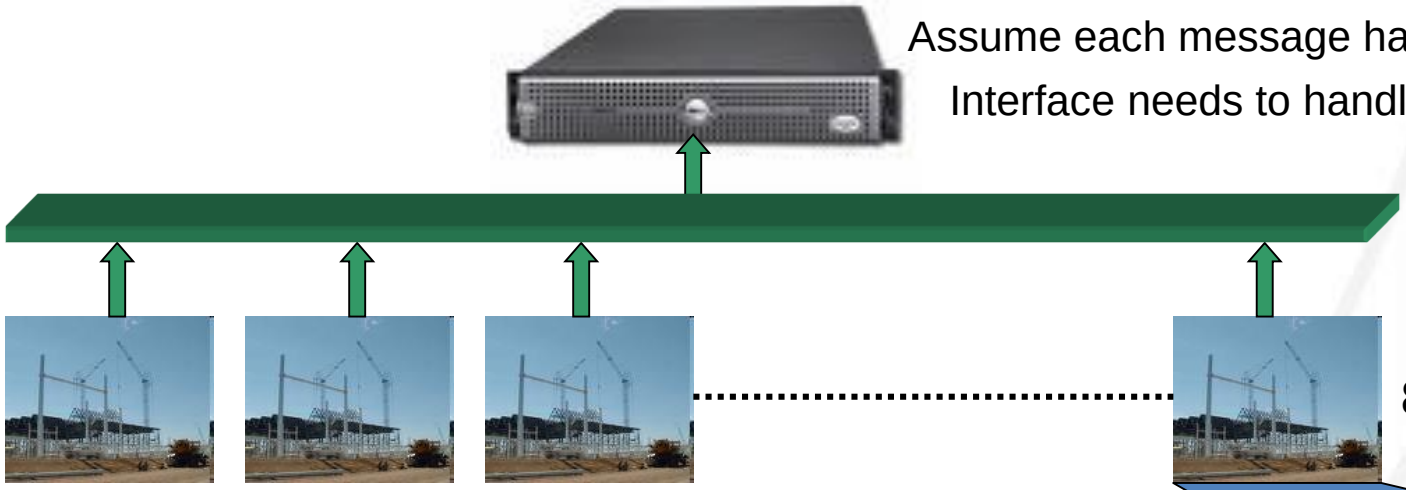
Performance Design

- Needed to determine what is a worst case event
- Determine if an interface could be constructed to support communication requirements
- Prove that OSIsoft PI System can handle the worst case event.

What is a field event?

- Can be characterized as a burst (e.g. not a continuous stream).
- The burst will subside, but may change characteristics based upon field actions.
- Amount of data that changes will be “large” initially and then decrease.

Assumption: 640 data changes/10 msec

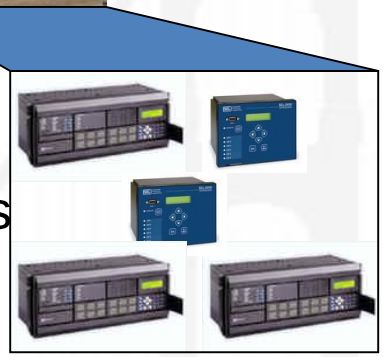


Assume each message has 8 data items change

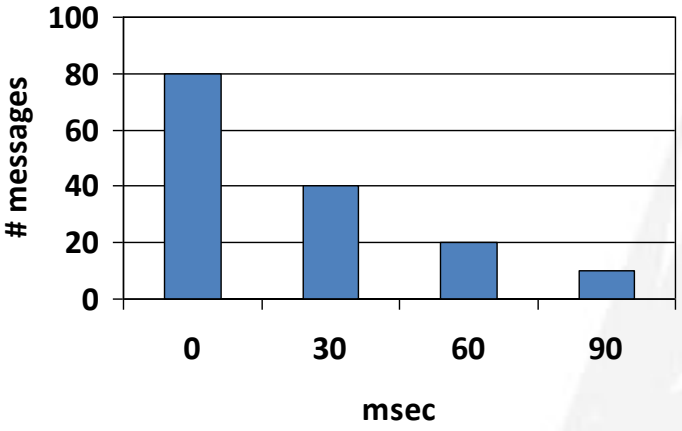
Interface needs to handle 80 messages

Assume 20% of devices report

80 Substations

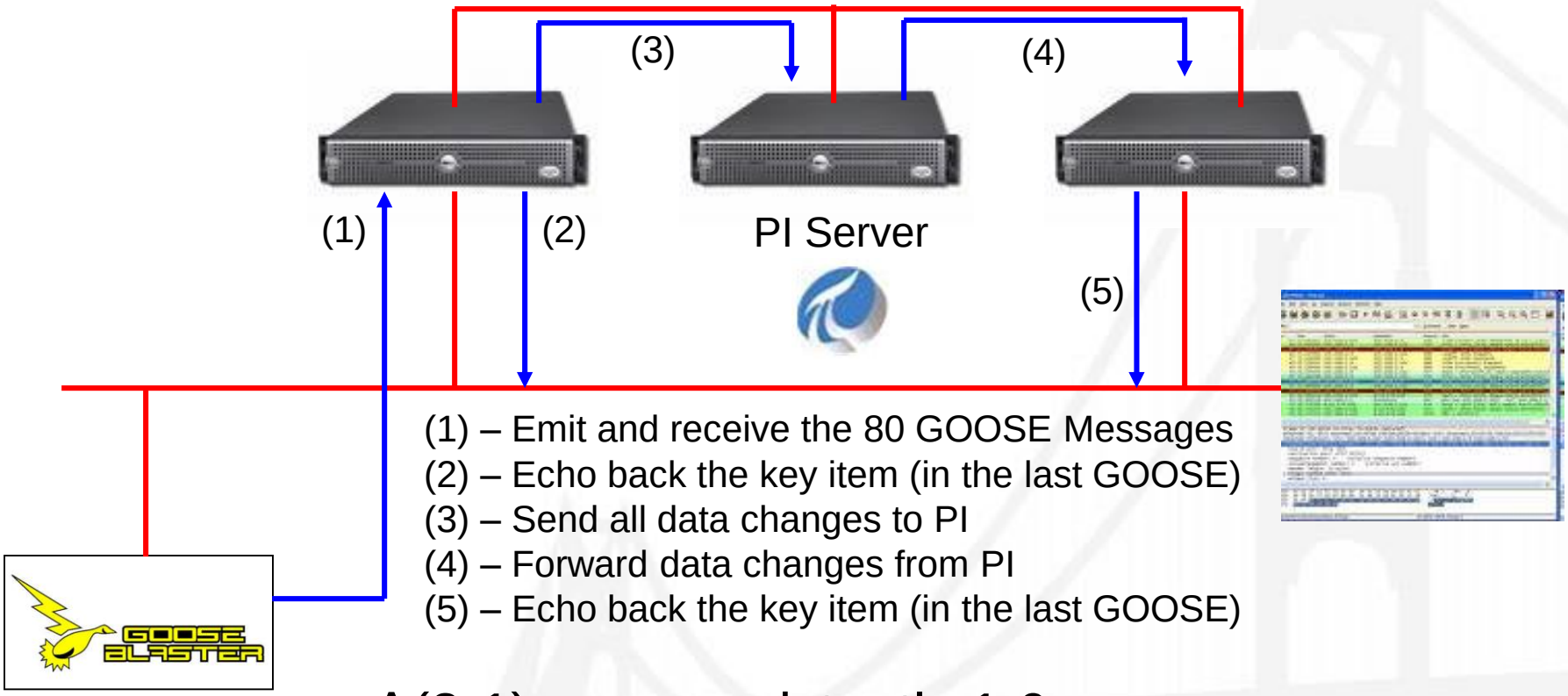


5-6 Devices



= 1150 messages per second

Test Set-up



(1) – Emit and receive the 80 GOOSE Messages
(2) – Echo back the key item (in the last GOOSE)
(3) – Send all data changes to PI
(4) – Forward data changes from PI
(5) – Echo back the key item (in the last GOOSE)

Δ(2-1) was consistently 1.6 msec
Δ(5-1) varied from 5 -10 msec

The variance…

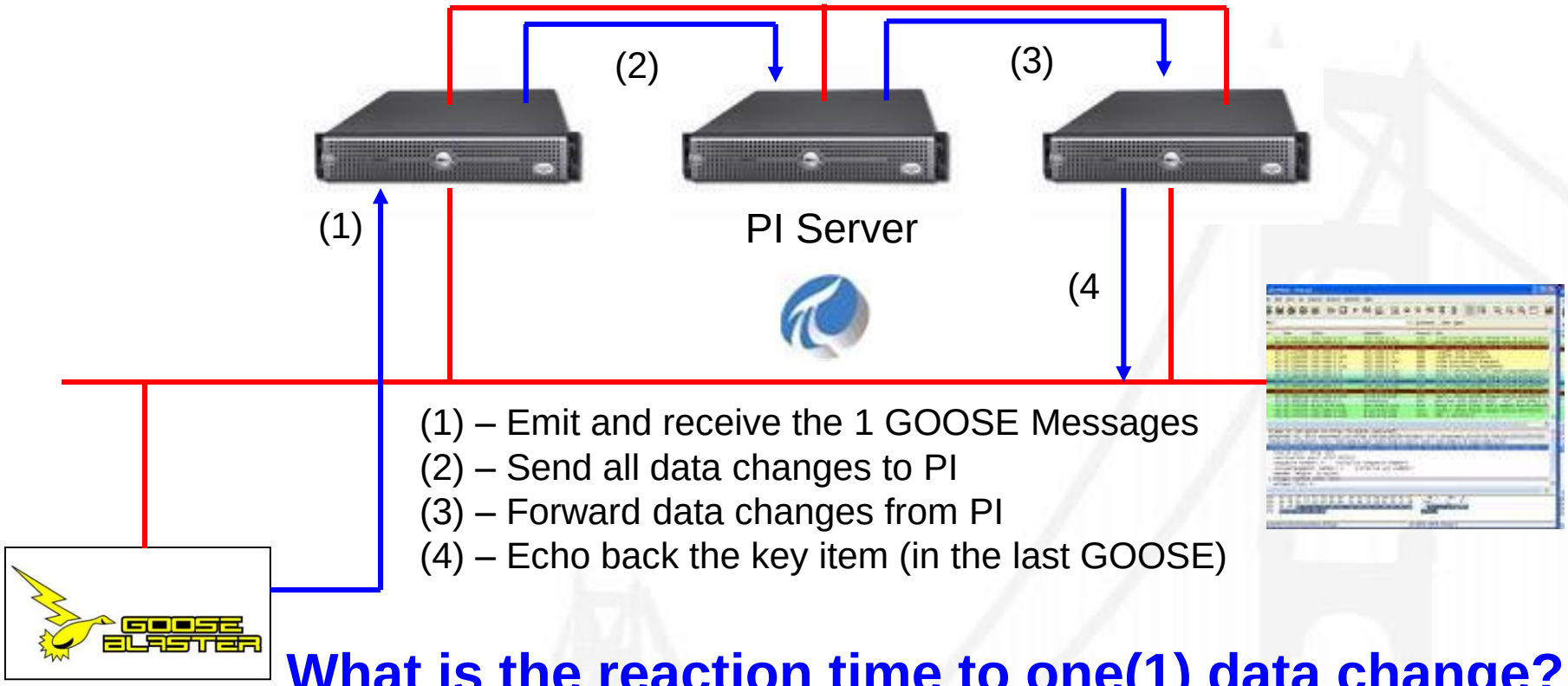
- Was able to be decreased by understanding interaction and threading model.
- Could be instrumented with PI performance counters and Windows Performance monitor.
  - Recommend PI users get familiar with these counters…

The importance?

- Allows PI to be used so that analytics can consume information from other interface nodes and still meet the 50 msec criteria.

- The design criteria of coordinating 80 substations has been increased to 880 (potentially).

Enquiring minds want to know:



What is the reaction time to one(1) data change?

Answer: 1-7 msec

Summary

OSIsoft PI System allows to accomplish

- High Performance
- Large $$$ Savings
- Maintainable
- Testable

Questions ?