On-line Process Analyzers - Quo Vadis?

(about prima donnas, dinosaurs, etc.)

Peter van Vuuren
Optograf™ Product Manager
SpectraSensors/Kaiser Analytics
Jan 20, 2011

Process Analysis Value Proposition

- **Cost to Buy/Build/Install**
- **Cost to Own**

$Measurement value$
"Analyzer Credits"

TCO

- **Profit Center?**

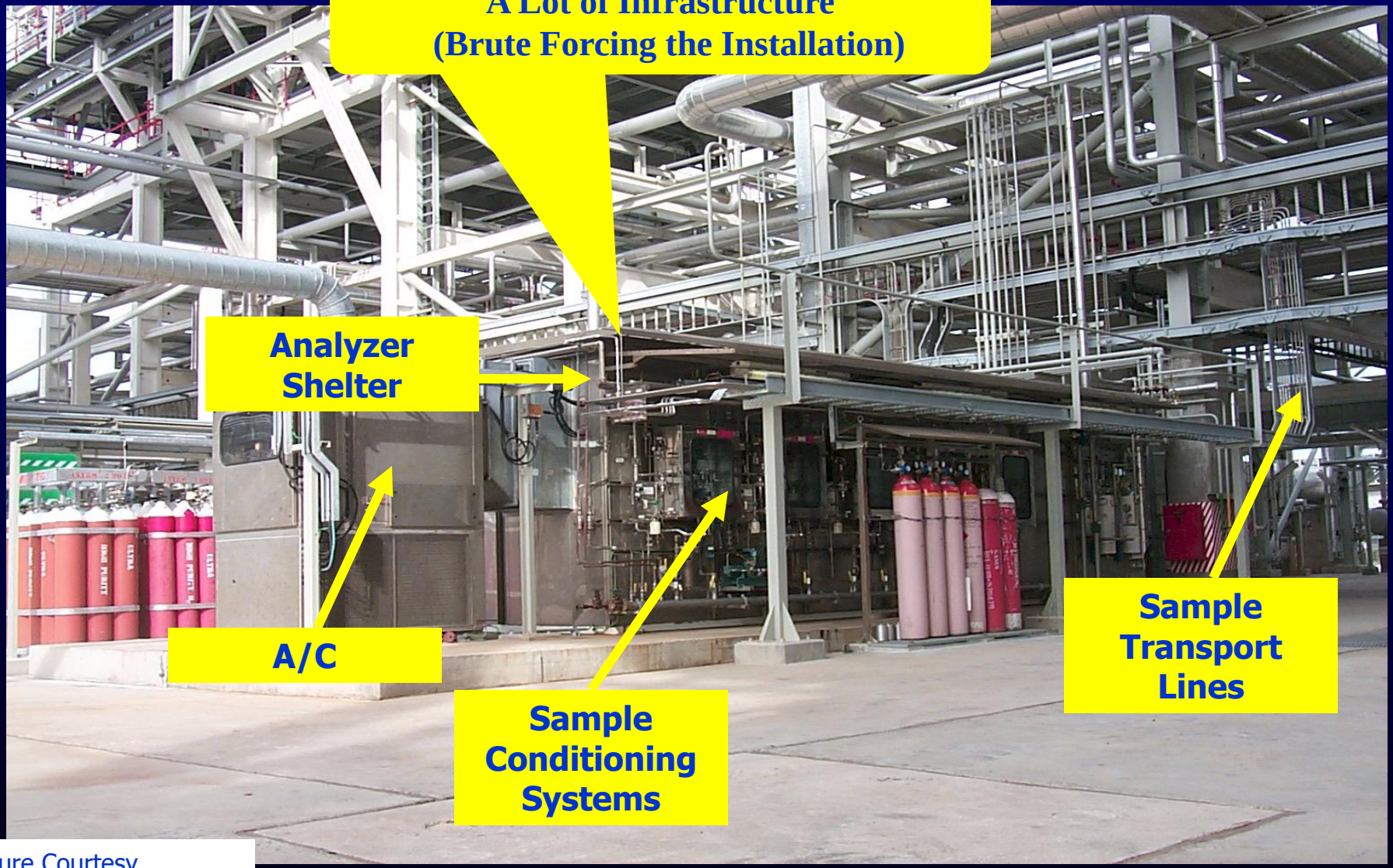
$Bottom-line Value$

- **Cost Center?**

- Safety
- Efficiency (Control/Optimization)
- Environmental

Picture Courtesy
ExxonMobil Chemical

TCO Considerations



Picture Courtesy
ExxonMobil Chemical

TCO Considerations

Picture Courtesy
ExxonMobil Chemical

TCO Considerations

Sample Conditioning Systems:

* **Custom designed, engineered and built**
* **Lots of tubing/fittings**
* **Many man-hours designing/building it**
* **Lots of discrete components**

Cost Issue – Irritates the Bean Counters

* **Typically not Smart**
  (Smart = knowing if p,t,f of sample are normal, i.e. validating representative sample)

"Quality of Measurement Issue" - Credibility of analysis

Picture Courtesy
ExxonMobil Chemical

TCO Considerarations

Picture Courtesy
ExxonMobil Chemical

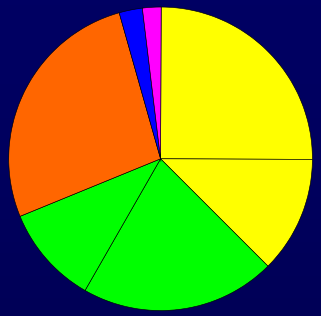
An Analyzer Prima Donna?

Real Prima Donna	Analyzer Prima Donna
His/her Own Dressing Room + a big  on the door	Same  on the outside door missing
All the necessary facilities to make the room meet all his/her needs: Air conditioning	Air conditioning, own instrument air, hazardous area adaptation etc., vent lines, headers
His/her own bar (food, drinks etc.)	Its own sample at the right pressure and temp
Has his/her own entourage: Hairdresser, pedicurist, manicurist etc.	Technicians, analyzer engineers etc.

Cost to Build/Install/Own – Major Greenfield Project

	Number	K USD each	K USD total	PCT
Gas chromatographs	50	30	**1500**	38
Other analysers	75	10	**750**	
Sample systems	125	10	**1250**	30
Sample transport	125	5	**625**	
Analyser houses	8	200	**1600**	27
Data system	1	150	**150**	3
Installation costs	1	125	**125**	2
TOTAL			**6000**	

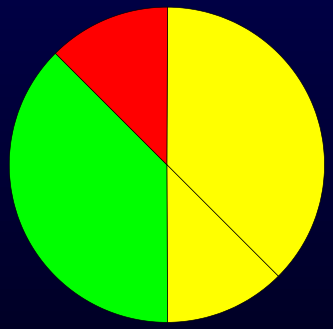
To Buy/Build/Install



Lifetime	15	years
Number of equivalent analysers	250	
Equivalent analyser per technician	50	
Cost of spares per equivalent analyser / yr	1200	USD

	Number	USD / hr	K USD / yr
Technician	5	30	300
Engineer	1	50	100
Spares			300
Consumables			100
TOTAL / yr			**800**
TOTAL / life			**12000**

To Own



J.J. Gunnell and P. van Vuuren, "PROCESS ANALYTICAL SYSTEMS: A VISION FOR THE FUTURE" Plenary Session Paper, IFPAC2000, Las Vegas, NV

Total Cost Of Ownership – A More Detailed Look

Buy/Build

- Analyzer $/ Spare Parts
- Sampling Systems
- Shelters/Panels
- Data System

- Sample Tap / Transport Lines
- Utilities (IA, Carrier Gases etc.)
- Power
- Cabling

Install

- Shelters/Panels
- Hookups :
  Utilities, Power, Cabling, Sampling Systems
- Start-up & Commissioning

Own

- EQAT (Manpower)
- Consumables
  * Standards
  * Support Gases
- Spare Parts

Failure

- Off-line Time
  Missed Opportunity
- Process Upset
  Loss of Production

$ = X2

Cost to Buy/Build &Install

Cost to Own/Operate

What to do?

"When men got structural steel, they did not use it to build steel copies of wooden bridges."

Ayn Rand. *Atlas Shrugged*. 1957.

Or as Rob Would Say

"When analyzer men got NeSSI they did not use it to build duplicates of legacy sampling systems"

Rob Dubois

NeSSI = Sampling & Communications Platform

DCS

o&m user

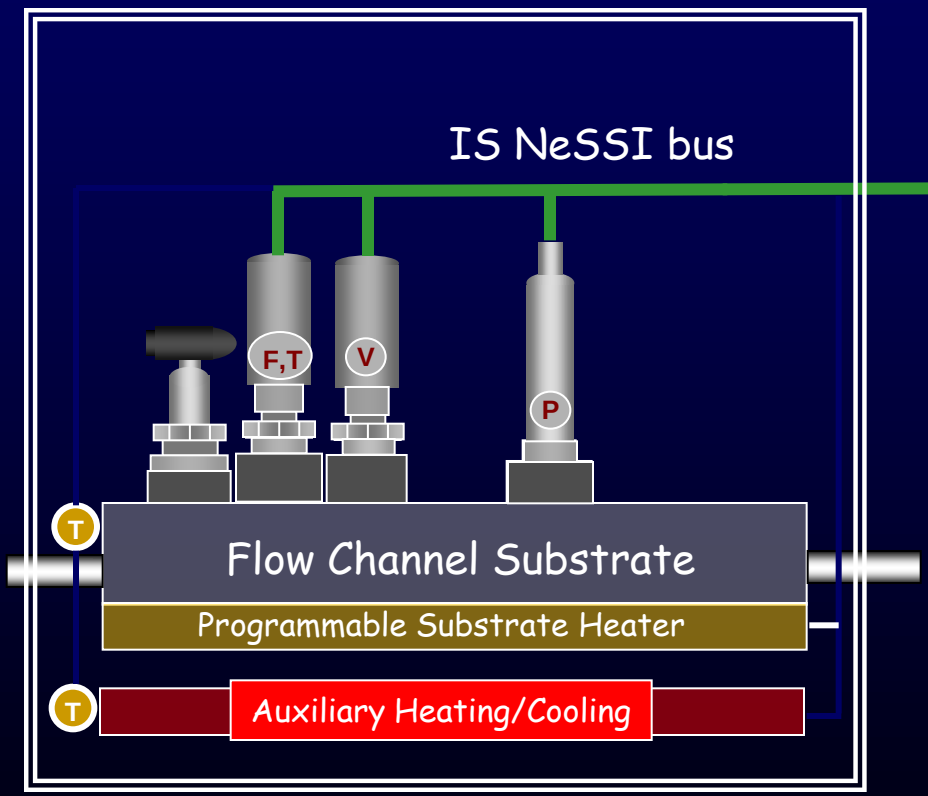
GP Area

Field – Classified Area

Ethernet LAN

Sensor/Actuator Manager (SAM)

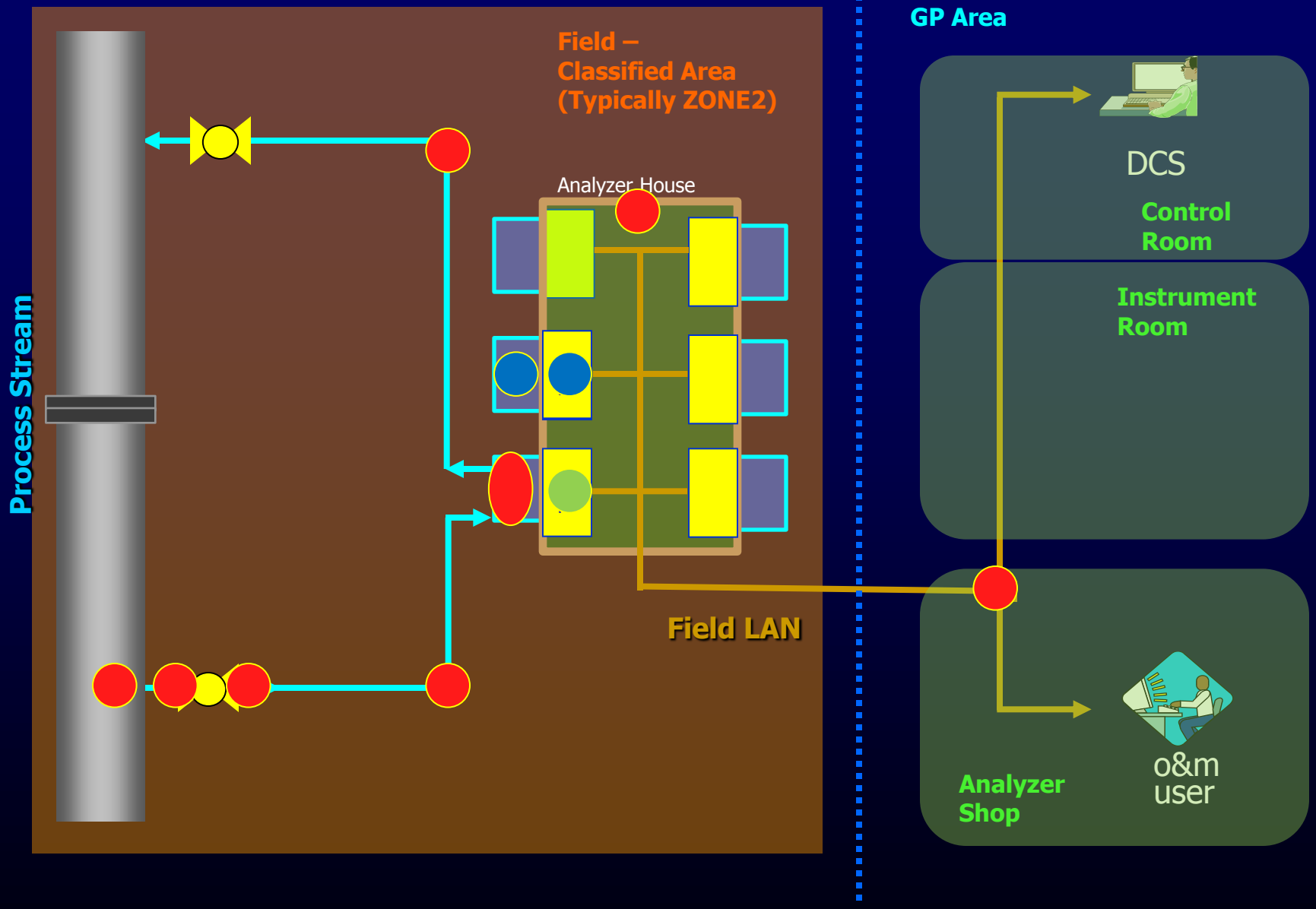
IS NeSSI bus



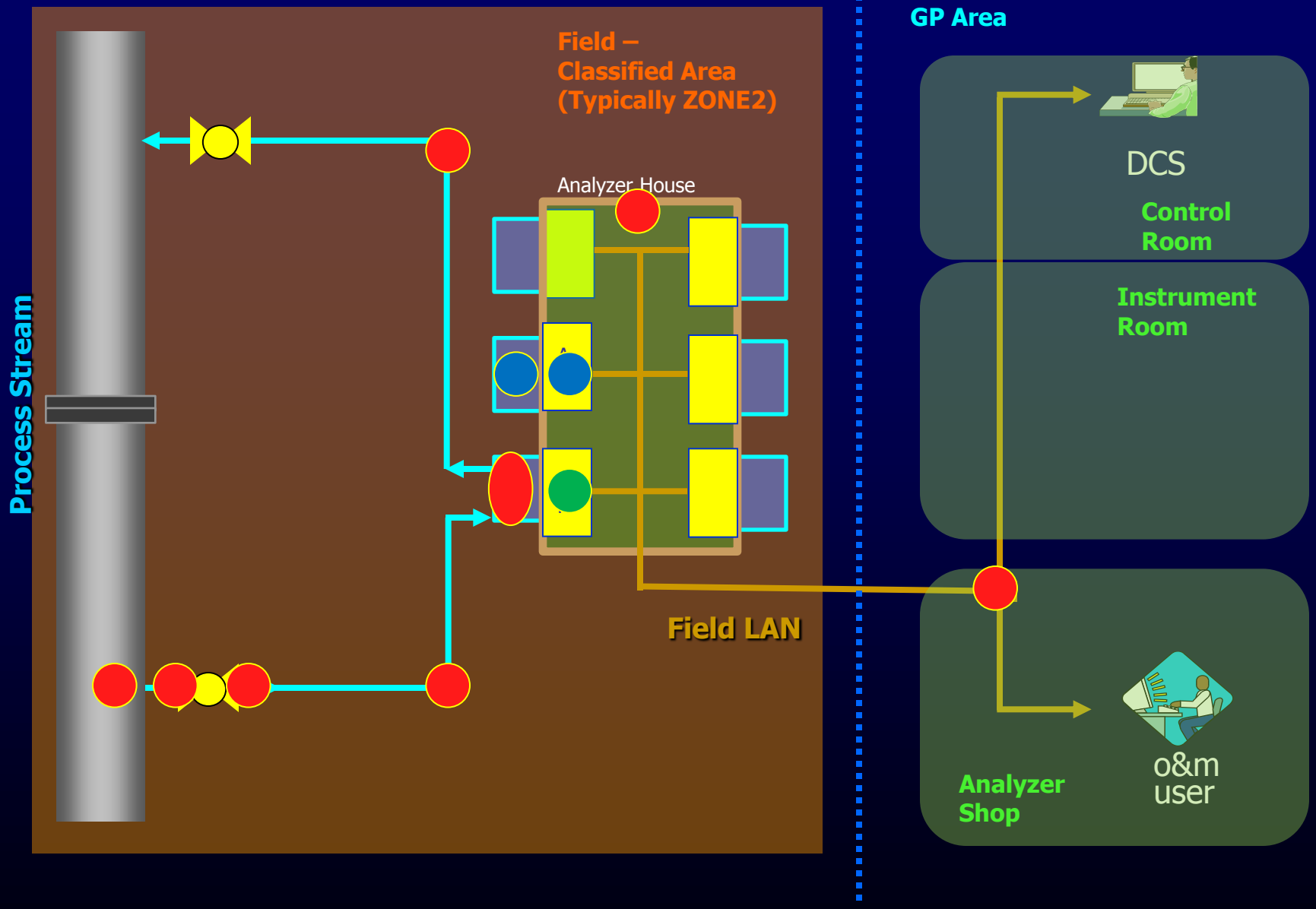
Micro- Climate enclosure

PDA

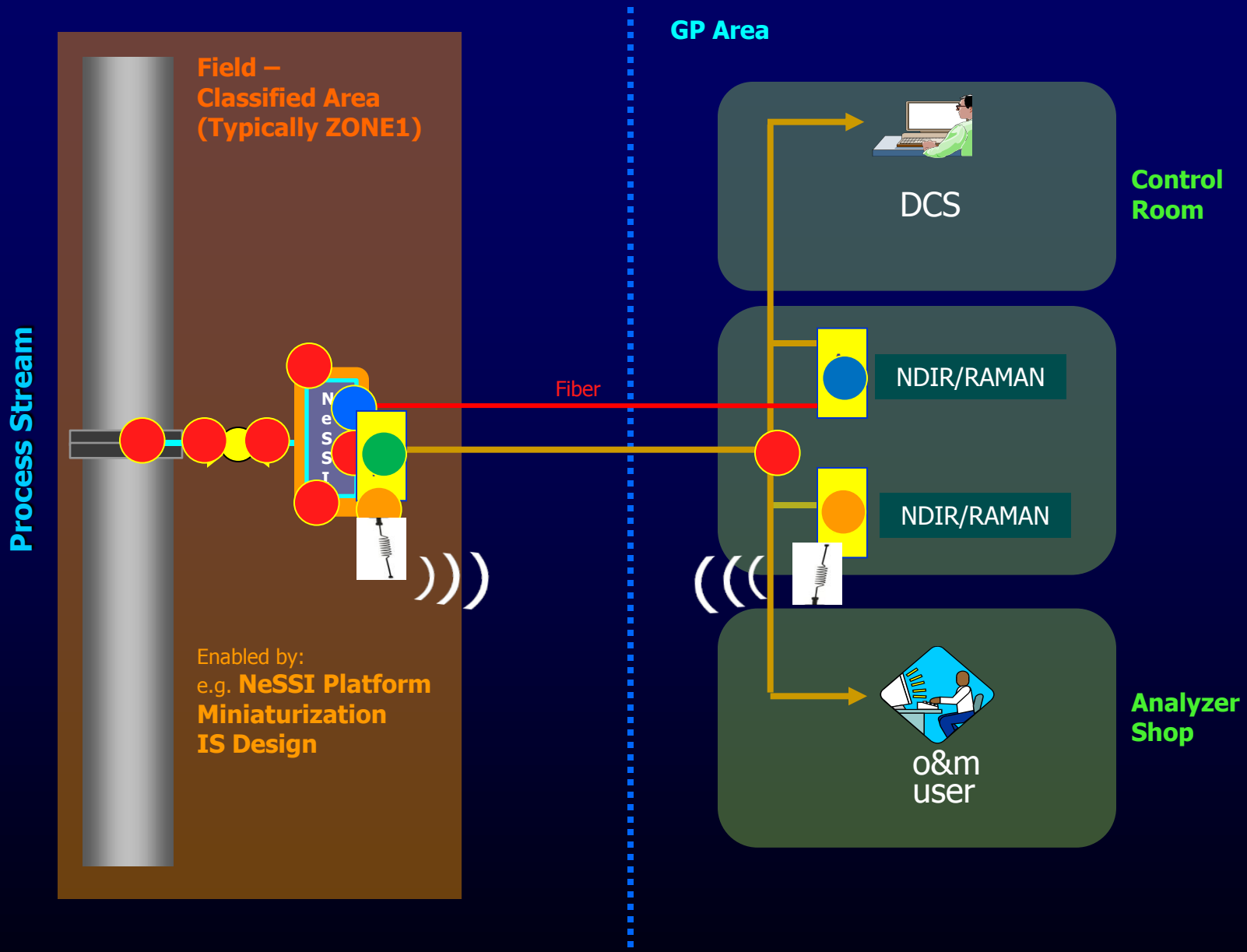
Connecting the DOTS



Moving the DOTS



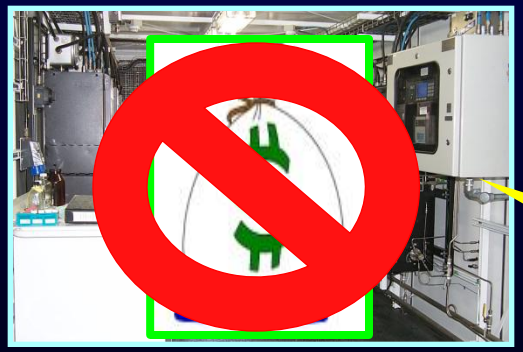
Enabling Topographical Changes: FUTURE



Total Cost of Ownership - Gen III Vision

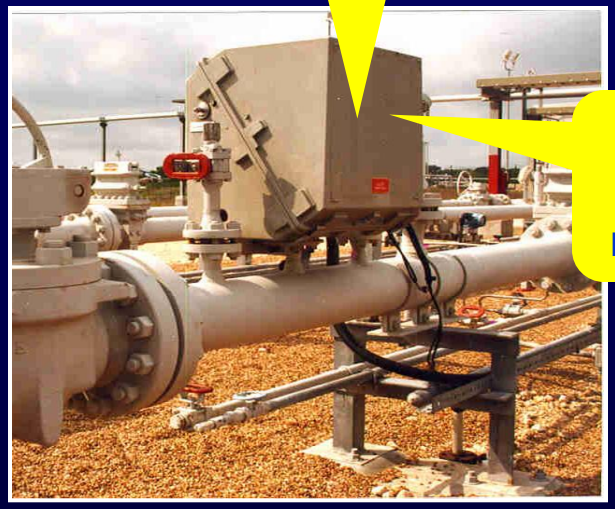
Macro-House

Legacy SS



Macro-Analyzers

Micro-House
@ Sampling Point



NeSSI Platform
Intrinsically Safe
Micro-Analyzers
Fiber-Optic probes

Courtesy of Dow Chemical, Freeport, Texas

Intensive/Major Infrastructure Requirements → **Minimal Infrastructure Requirements**

Process Analysis Value Proposition - TCO Optimized

$Measurement value$
"Analyzer Credits"

TCO

PROFIT

Cost

$Bottom-line Value$

TCO

$Bottom-line Value$

Perception of Process Analytics: Profit Center

If we look down the road:

What should the attributes of the ideal next generation analyzer system be?

Sample probe

- In the pipe or at the pipe
- High temp and flows
- Filtering of particulates
- Removal or rejection of condensables
- No or limited sample removal (in/ex situ sampling)

Sample handling

- At line or near line pressure
- Minimal sample conditioning
- No sample transport
- No sample return required
- Ports for calibration/validation
- Pressure and Temperature (and Flow Measurement)

Attributes of the ideal next generation analyzer system?

Analyzer sensor/controller

- Poles to tropics operation
- Does not require an analyzer shelter
- Intrinsically safe or flame proof (miniature)
- No or few moving parts (inherently reliable)

Communications

- With DCS
  - Serial data links OPC, Modbus TCP/IP
  - Future wireless
- With maintenance LAN
  - Separate and firewalled from DCS and other plant devices & LANS
  - Diagnostics/history/setup
  - Remote access/operations (off-site maintenance)
  - Wired or Wireless

Tutorial Conclusion

- We must change if we want to avoid becoming a dinosaur technology.
- It's now time to move ahead with Generation III
  - A scorecard to set the stage for on-line methodologies is underway.
  - microAnalytical is our future - now

Thank You

Micro-analytics Design Requirements

- Understand the NeSSI Platform Concept (Enabler)
  * Provides a Standardized Micro-Infrastructure Environment for Deploying micro-analytical sensors/Analyzers
  * At the same time, allows for IP protection
- IS has to be designed in up front
- Design for temperature accommodation/correction
  * NeSSI platform can be installed anywhere (Zone 0/1/2 GP) – no costly purge systems
- Design for validation of results (Good Housekeeping Seal)
  * Use all the analytical process information for validation
- Design for no or little consumables
- Design for mecahnical simplicity – no or few moving parts
- Design for extensive but smart diagnostics

The Case for a Micro-Analytics Initiative at CPAC

- The NeSSI slogan is apropos: "The best way to predict the future is to create it"
- Clearing House for Micro-analytical Design requirements based on the NeSSI platform
  * Developments of new technology typically done in research center or academic environments
  * Design guidelines will accelerate product to market time
  * Can position the USA again as a leader in innovative analytical product development and commercialization
- Clearing House for Industrial Needs in search of a (micro)-analytical solution
- Provide a forum for facilitation/education/coordination
  * Annual conference on Micro-analytics (complimentary to Summer Institute)
- CPAC knows how to drive and manage an initiative
- Open the door to alternative funding sources?

Acknowledgements

- All the Believers (all of you and many others)
- My ex-colleagues at ExxonMobil
- CPAC (adopted NeSSI as a new IURC "business model")

- Special Tribute/Thank You to Rob Dubois

Analytical Clusters Concept > Going Micro All the Way

Macro-House

Macro-Analyzers

Micro-House

Micro-Analyzers

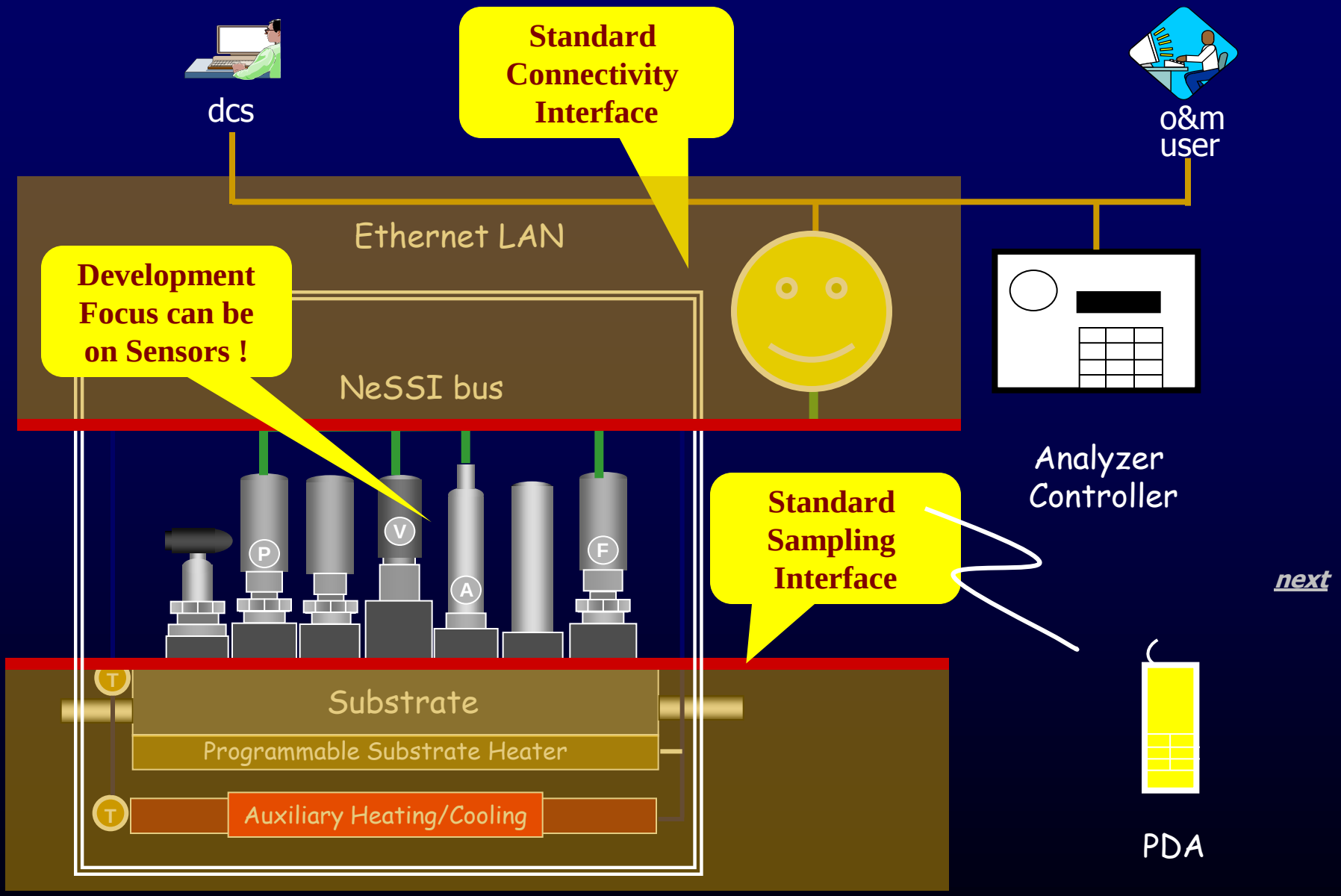
Pictures Courtesy of Dow Chemical Freeport, TX

Analytical Cluster = A Process Stream Requiring Multiple Analyte Measurements

Examples: On-line Propylene Certification
CEMS (Stack Analysis)
Cooling Water
Waste Water Treatment/Effluents

Byline Analytical Cluster = Multiple Analyte Measurements done on a Single NeSSI Platform

NeSSI "Sandwich/Rail" Platform Concept



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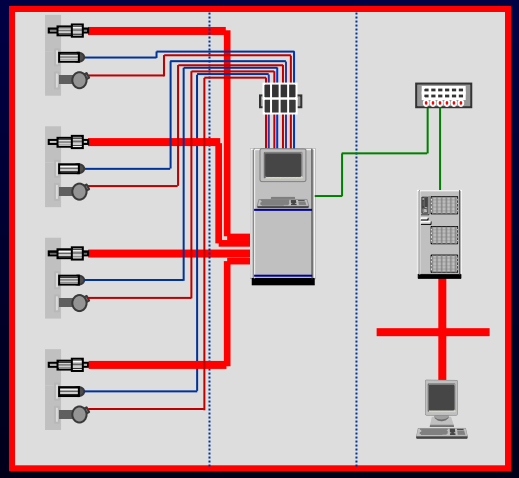

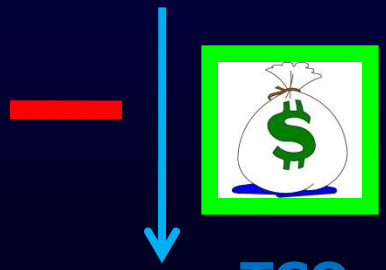

TCO

$Bottom-line Value$

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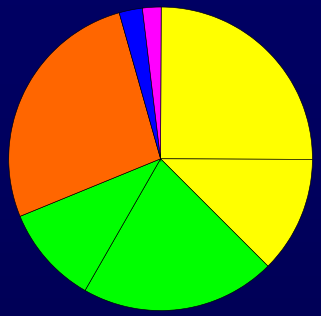
TOTAL			**6000**	

To Build/Install



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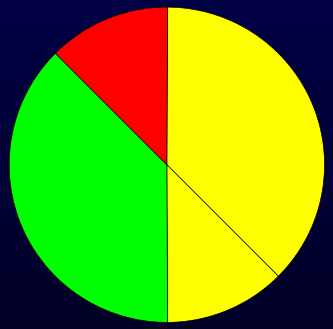

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Total Cost Of Ownership – A More Detailed Look

Build

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Install

- Shelters/Panels

Own

- EQAT (Manpower)
- Consumables
  * Standards
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Failure

- Off-line Time
  Missed Opportunity
- Process Upset
  Loss of Production

Sticker Shock Zone

Sticker Shock Zone

Rational/ Big Picture View

Cost to Buy

Cost to Own/Operate

+

TCO

Process Analysis Value Proposition

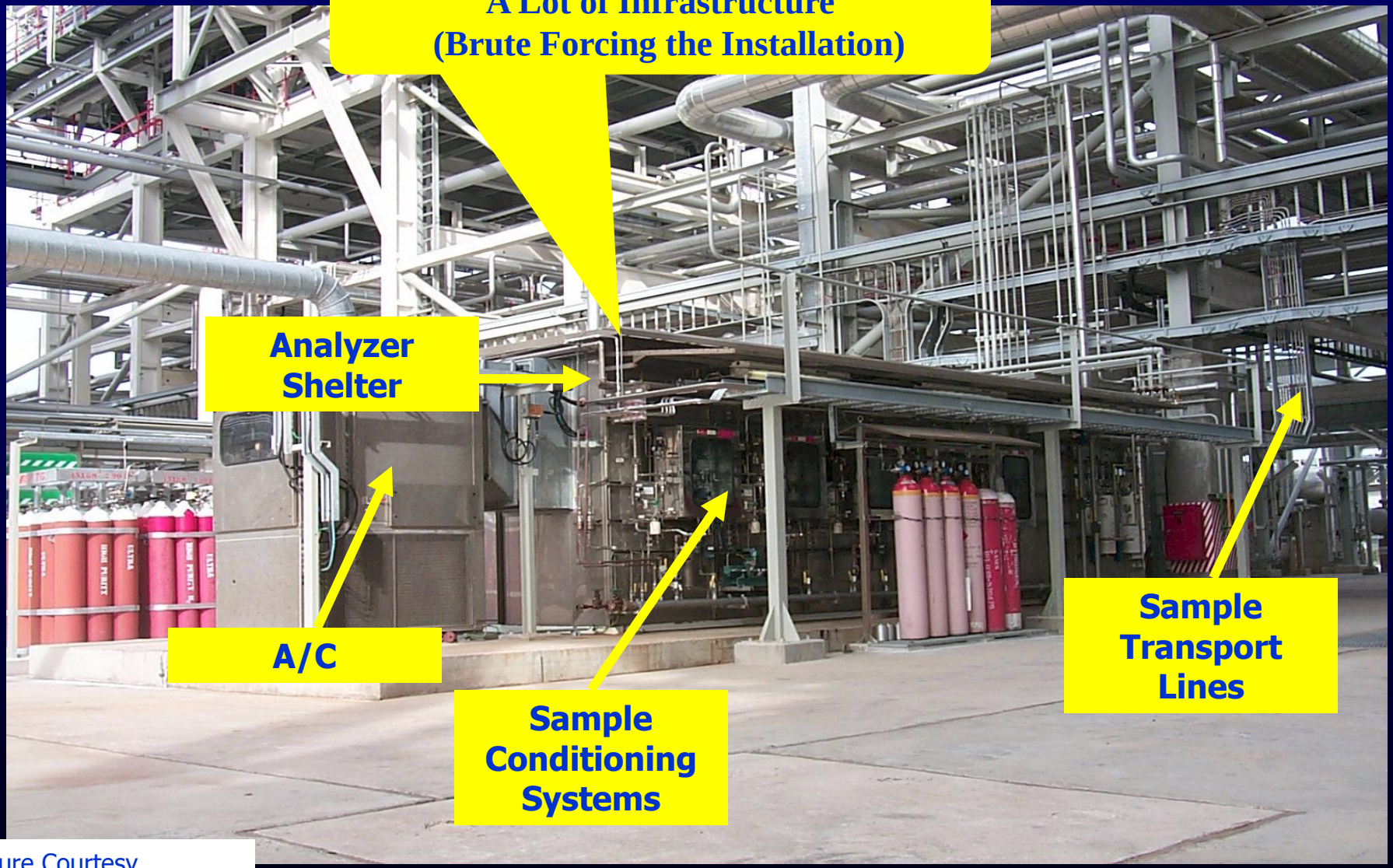
$Measurement value$
"Analyzer Credits"

TCO

$Bottom-line Value$

- Safety
- Efficiency
- Environmental

What is Wrong with these Pictures



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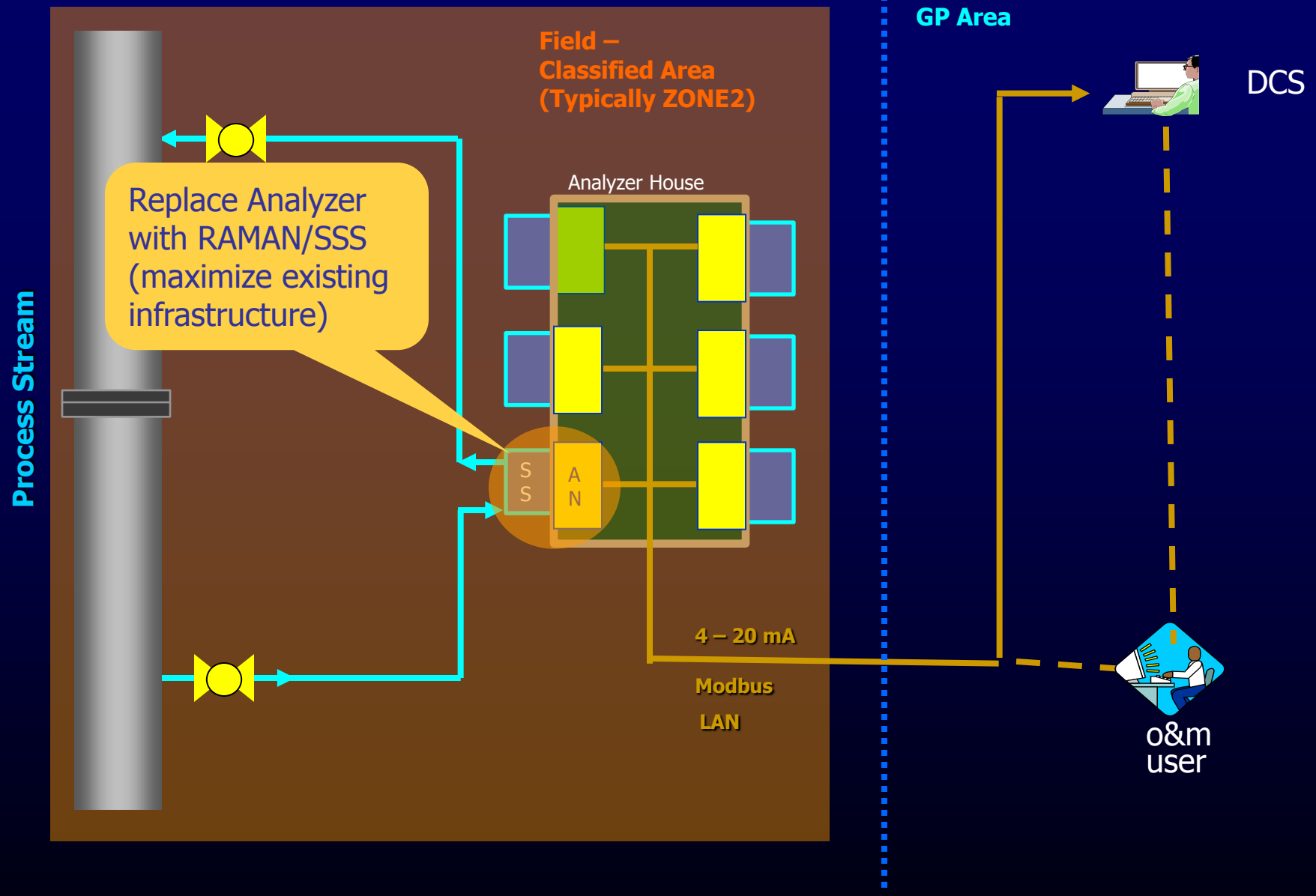
$ = X2

Cost to Buy

Cost to Own/Operate

Process Analytics Installation – Existing Analyzer Replacement



Optography

"Chromatography" with Laser Light

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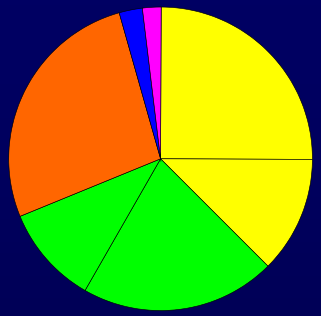

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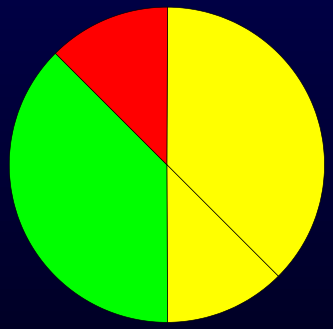

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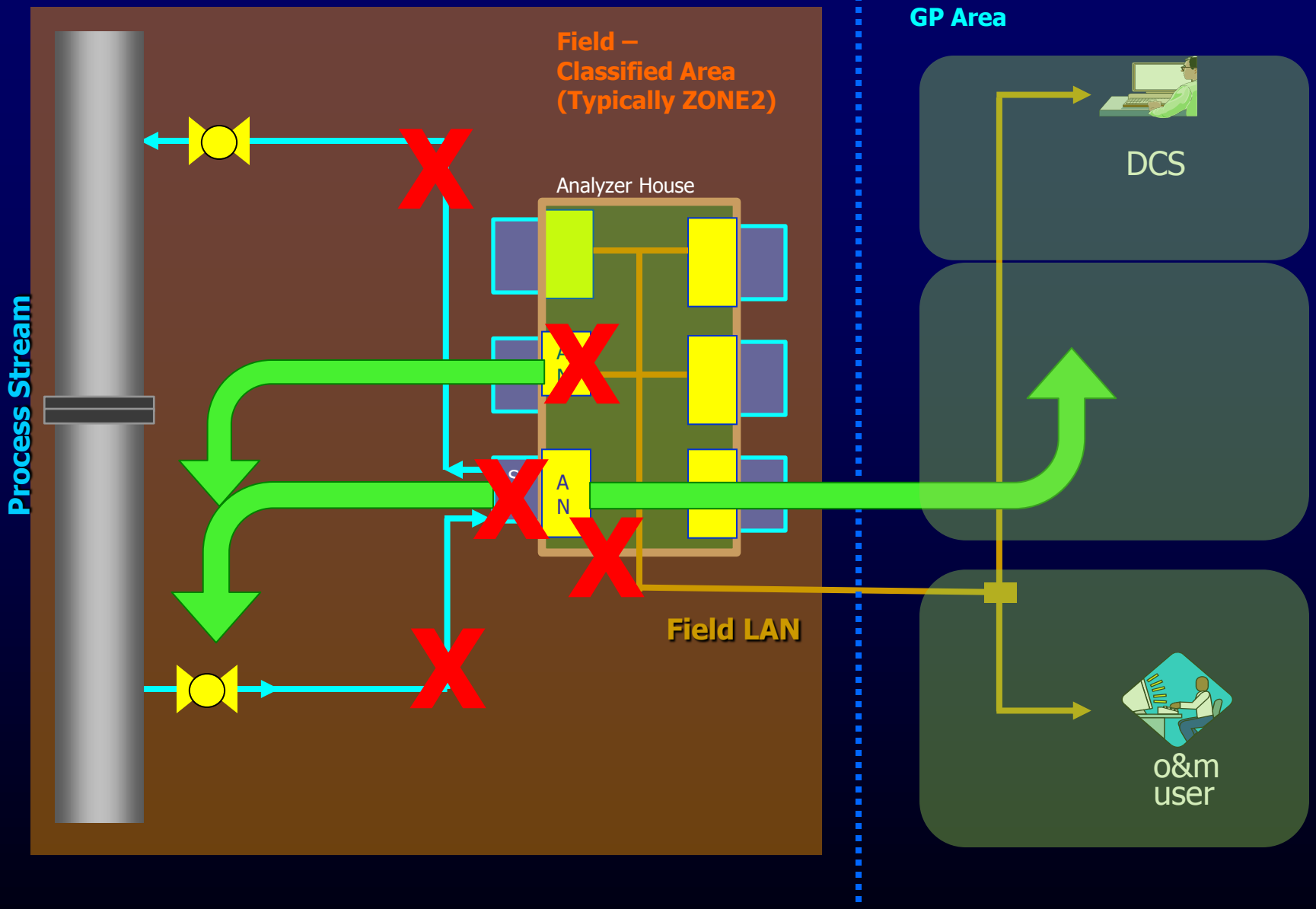
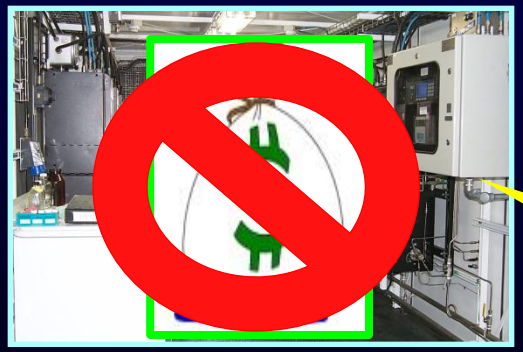
NeSSI Topography



Total Cost of Ownership

Macro-House

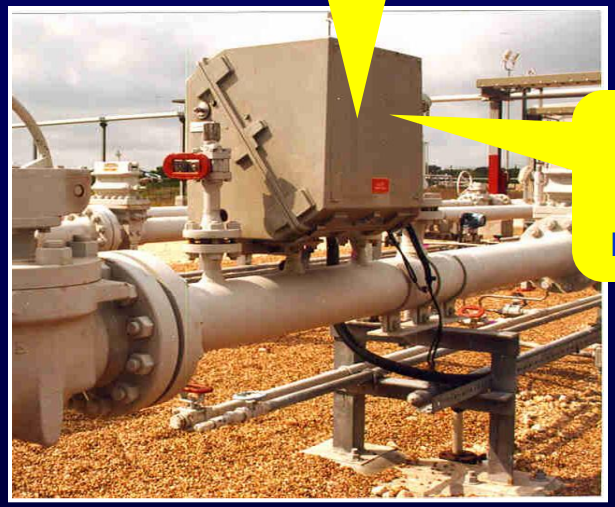
Legacy SS



Macro-Analyzers

NESSI $ VISION

Micro-House
@ Sampling Point



NeSSI Platform
Intrinsically Safe
Micro-Analyzers
Fiber-Optic probes

Intensive/Major Infrastructure Requirements → **Minimal Infrastructure Requirements**

BASIC NESSI TCO BENEFITS

Failure

- Off-line Time
  Missed Opportunity
- Process Upset
  Loss of Production

Own

- EQAT (Manpow
- Consumables
  * Standards
  * Support Gases
- Spare Parts

Fiber-Optic Sensors with NeSSI as Enabler

DCS

o&m user

GP Area

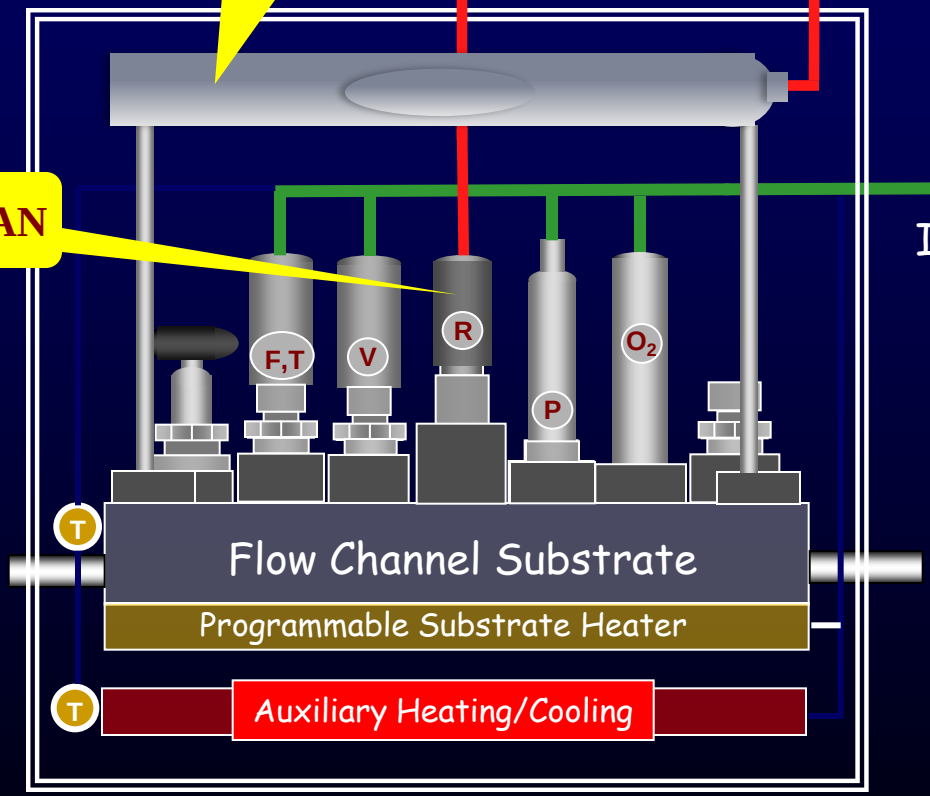
Field – Classified Area

TDL, CRDS, NIR…

Sensor/Actuator Manager (SAM)

RAMAN

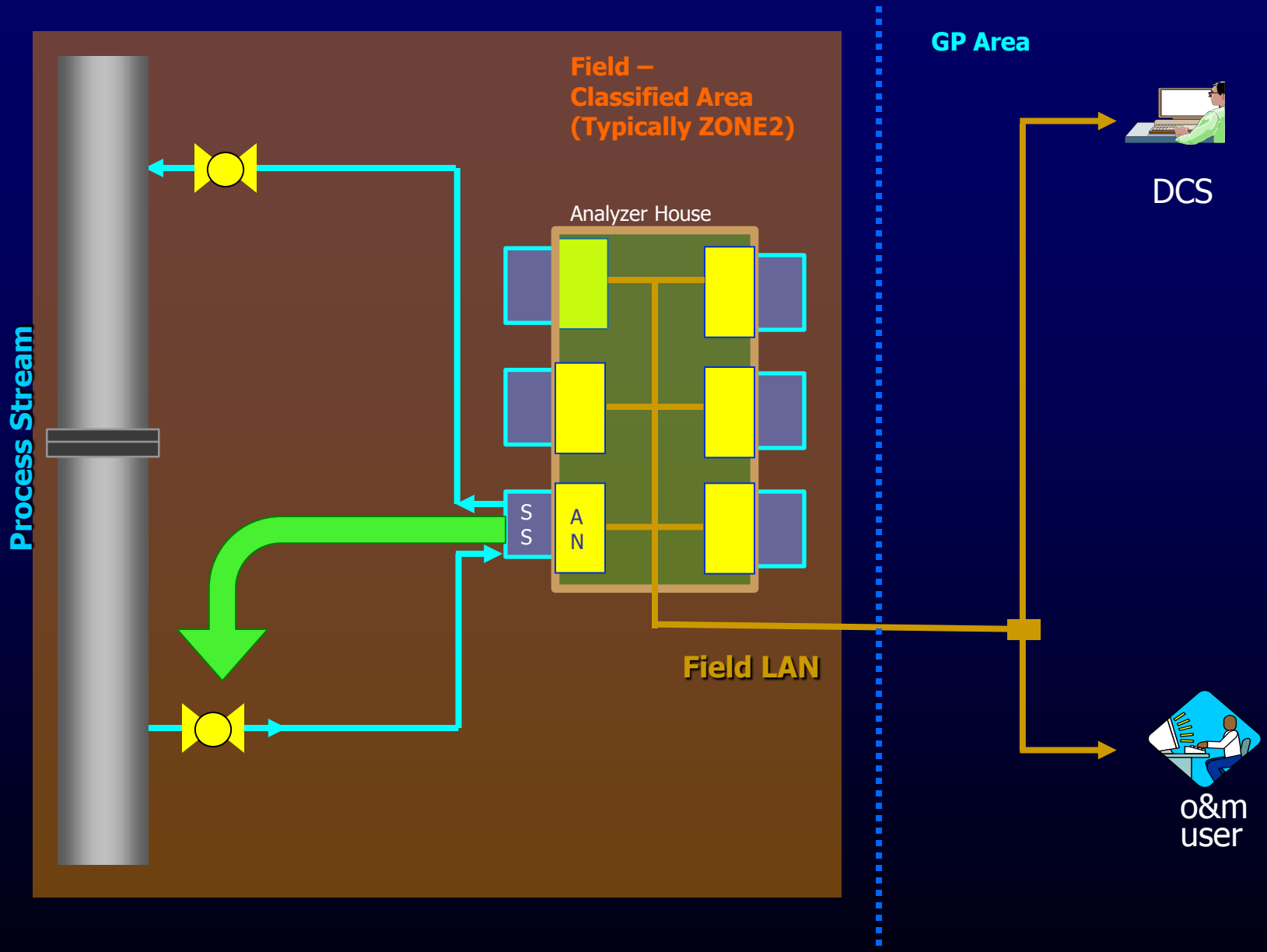
IS NeSSI bus



Micro- Climate enclosure

PDA

Process Analytical Infrastructure Topography



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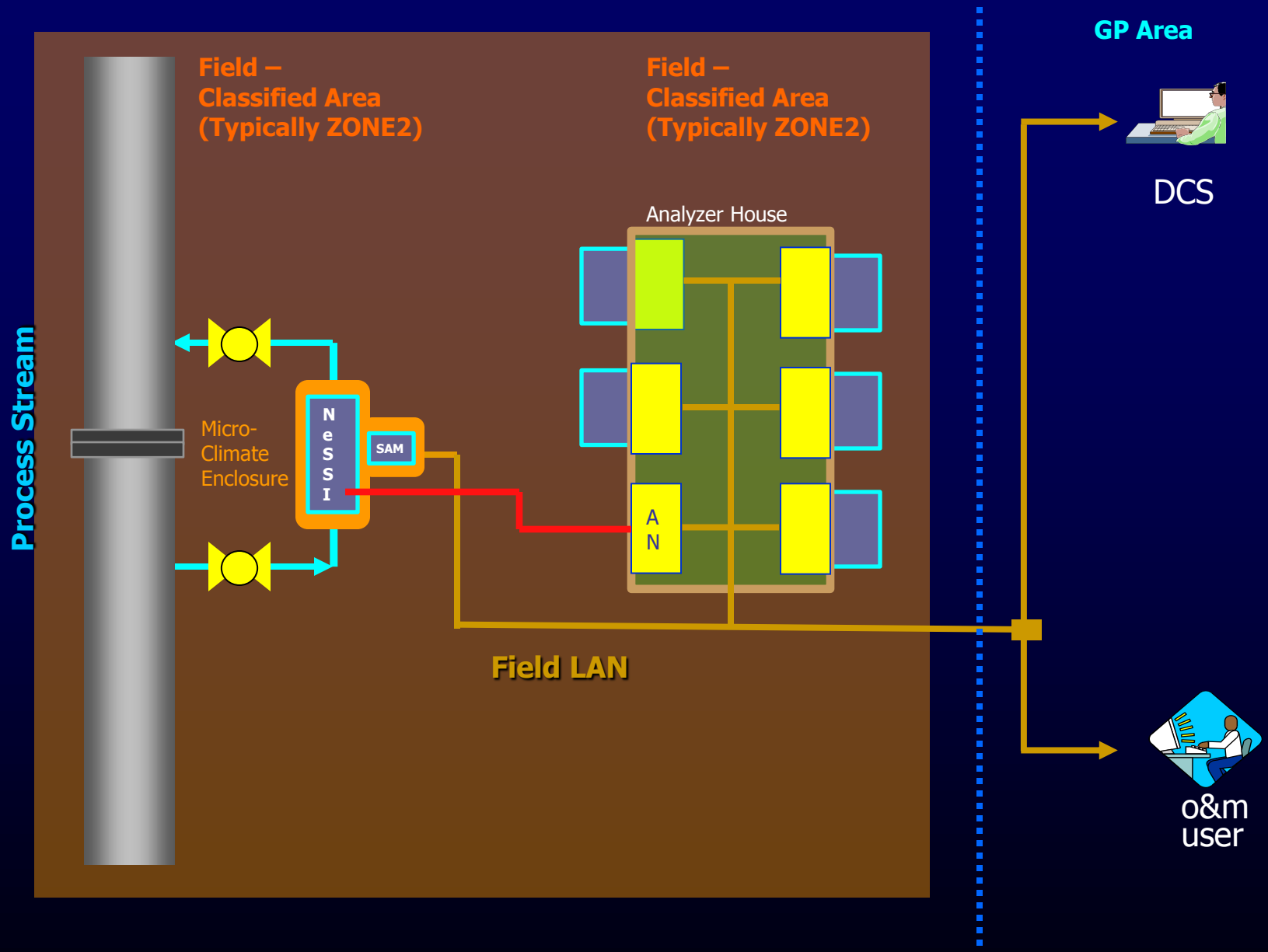

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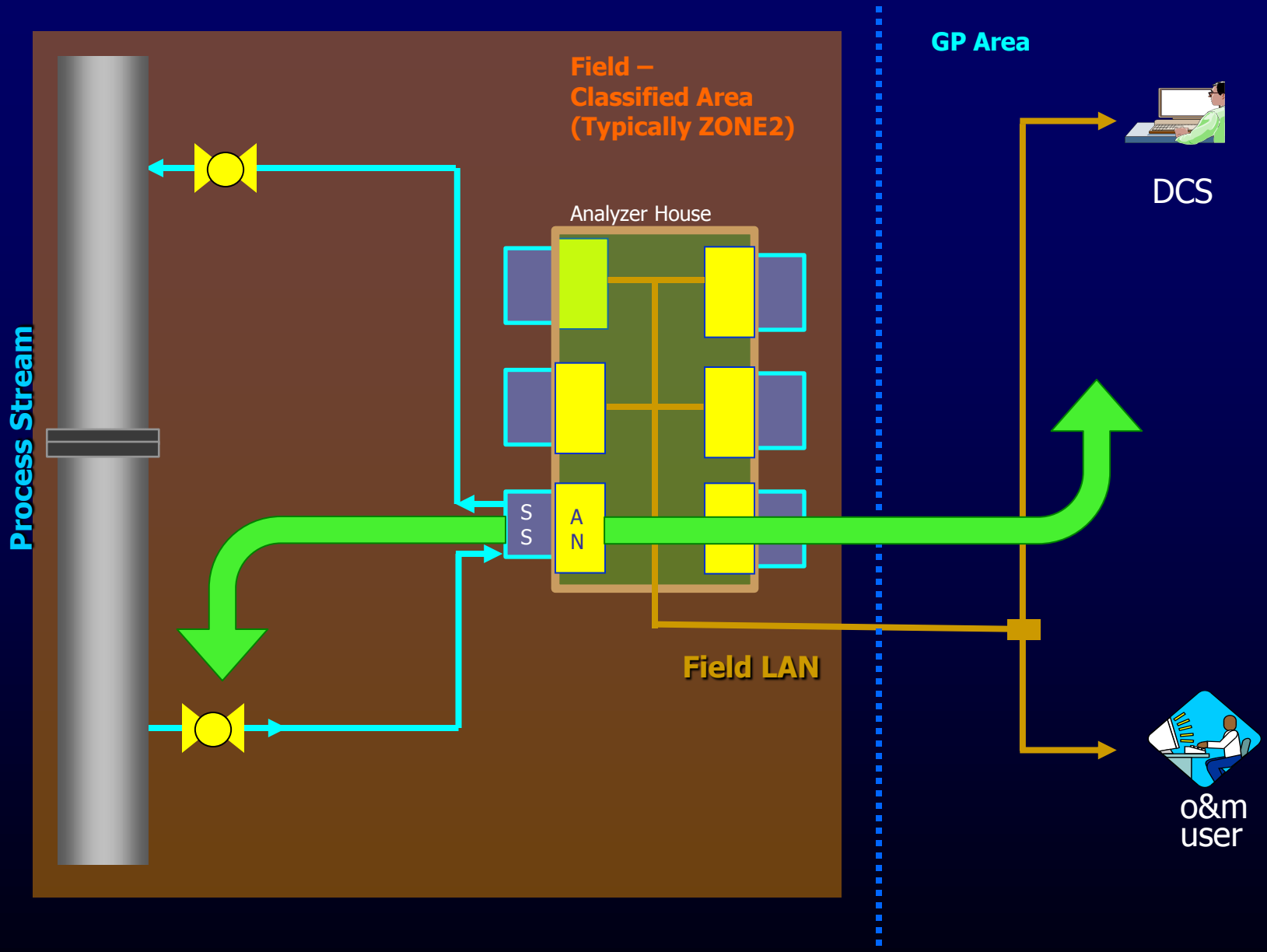
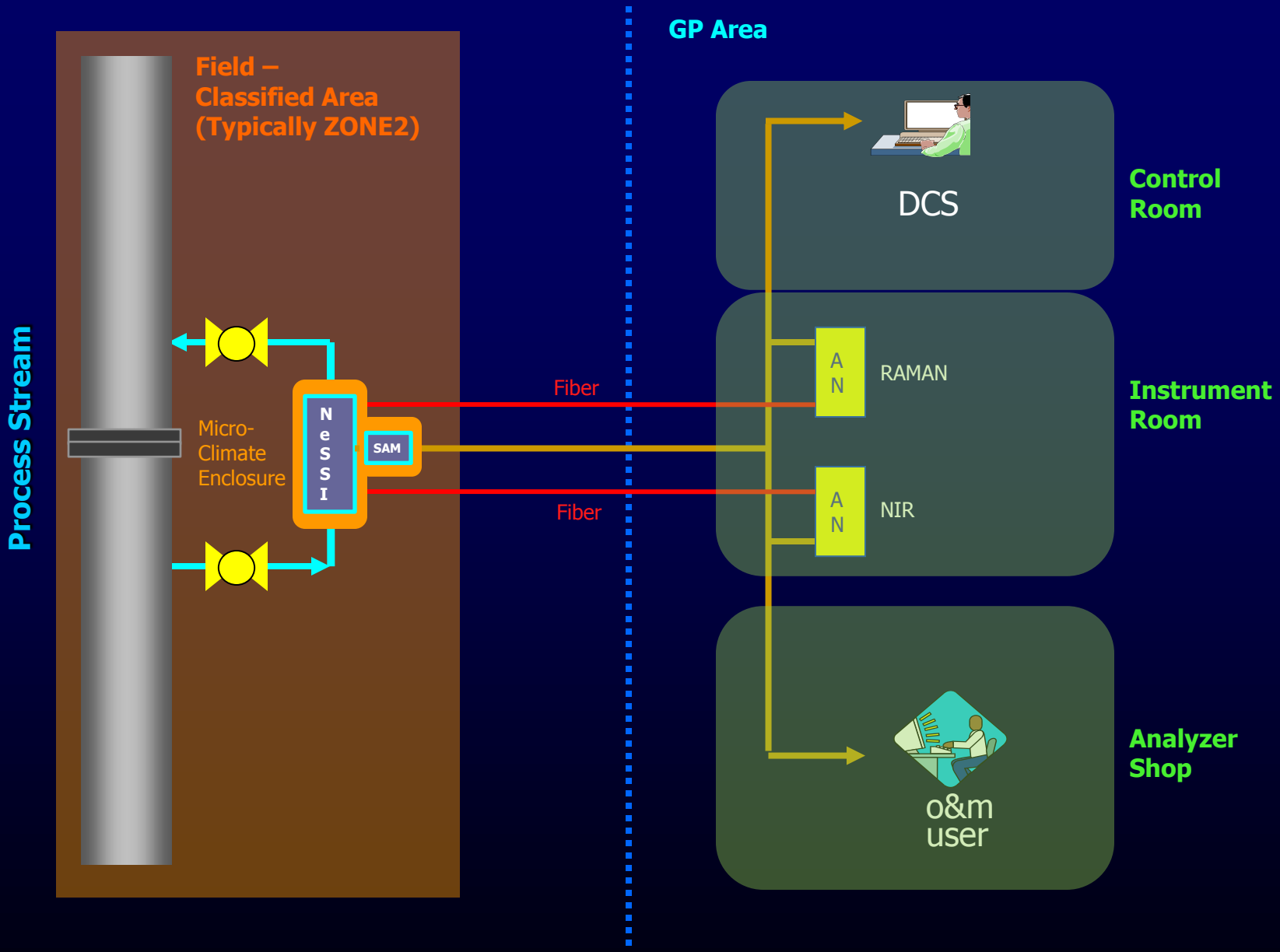


NeSSI Enabled Spectroscopy Process Analytics Topography



A TCO Optimization Strategy

- Phase 1 (On-Going)
  Implement Intrinsically Safe NeSSI where appropriate

- Phase II (Ready for Validation)
  Utilize NeSSI as a Platform for Fiber-Optic Sensors preferably at the Sampling Point (By-line Mode)

- Phase III
  Promote/Apply Micro-Analytical Sensors in By-Line Mode

NeSSI & Next Generation Micro Analyzers

DCS

o&m user

GP Area

Field – Classified Area

Ethernet LAN

Sensor/Actuator Manager (SAM)

IS NeSSI bus

F,T

V

P

Micro- Gas Analyzer (UV, MIR, MS, GC, …

T

Flow Channel Substrate

Programmable Substrate Heater

T

Auxiliary Heating/Cooling

Micro- Climate enclosure

PDA

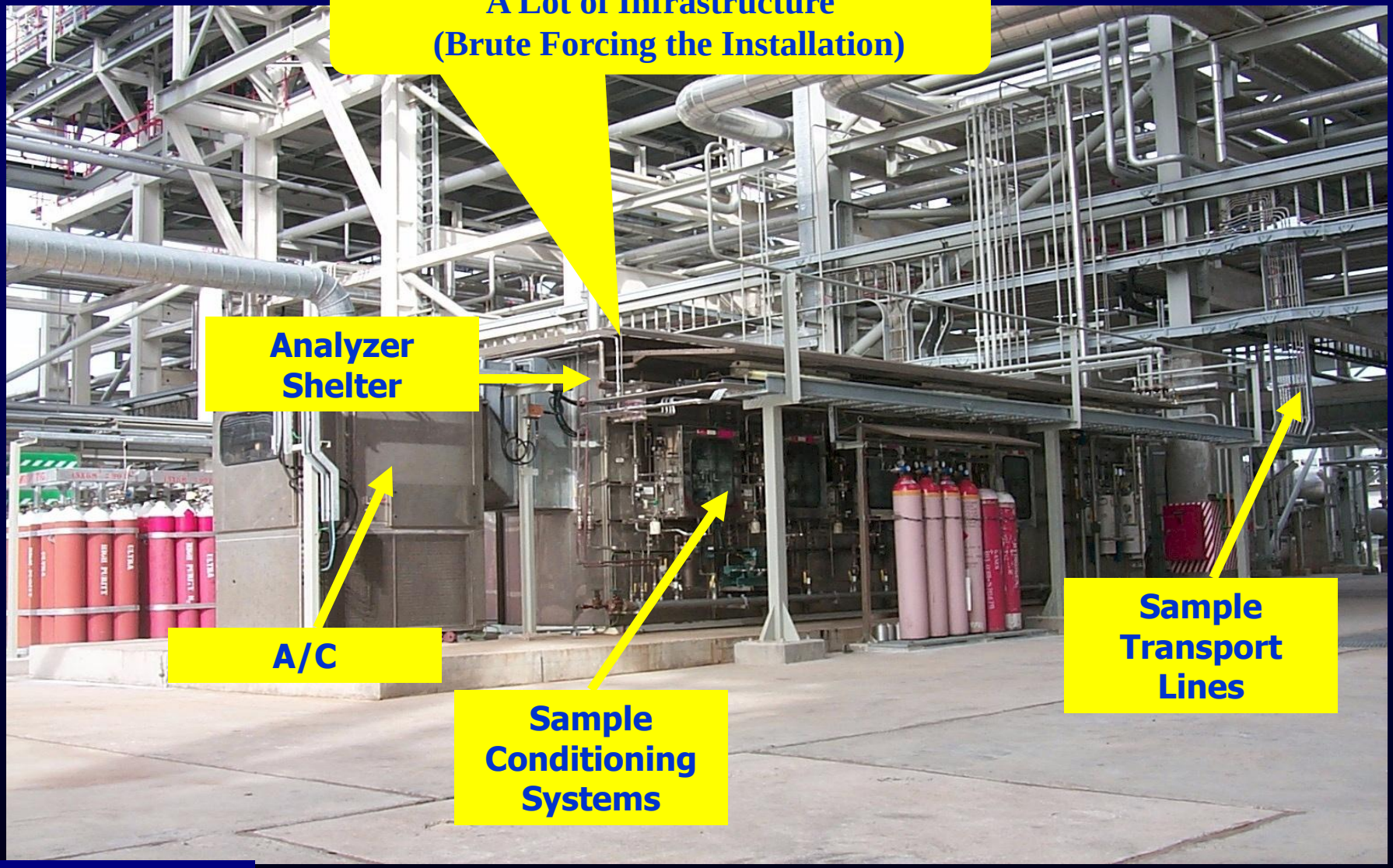
Topics for RAMAN Gas Analysis or Optical Chromatography

1. Role of Process Analytical Measurements
2. RAMAN Phenomenon
3. Optograms/Applications
4. Performance
5. Optography vs. Chromatography
6. Hardware
7. "Greening" of the User Interface
8. TCO Considerations

Role of Process Analysis

1. Enable Safe Operations
2. Implement Mandated Environmental Monitoring
3. Efficiency (Control & Optimization)
   * Quality of Data (Data Validation)
   * Reliability of Data (98+ Service Factor)
4. Total Cost of Ownership
   * Cost to Buy/Build/Install
   * Cost to Own (Manpower, Operating Costs)

TCO Considerations



Picture Courtesy ExxonMobil Chemical

TCO Benefits of RAMAN/Smart Sampling System

Build

- Analyzer $/ Spare Parts
- Sampling Systems
- Shelters/Panels
- Data System

- Sample Tap / Transport Line
- Utilities (IA, Carrier Gases etc.)
- Power
- Cabling

Install

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Own

- EQAT (Manpower)
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  * Standards
  * Support Gases
- Spare Parts

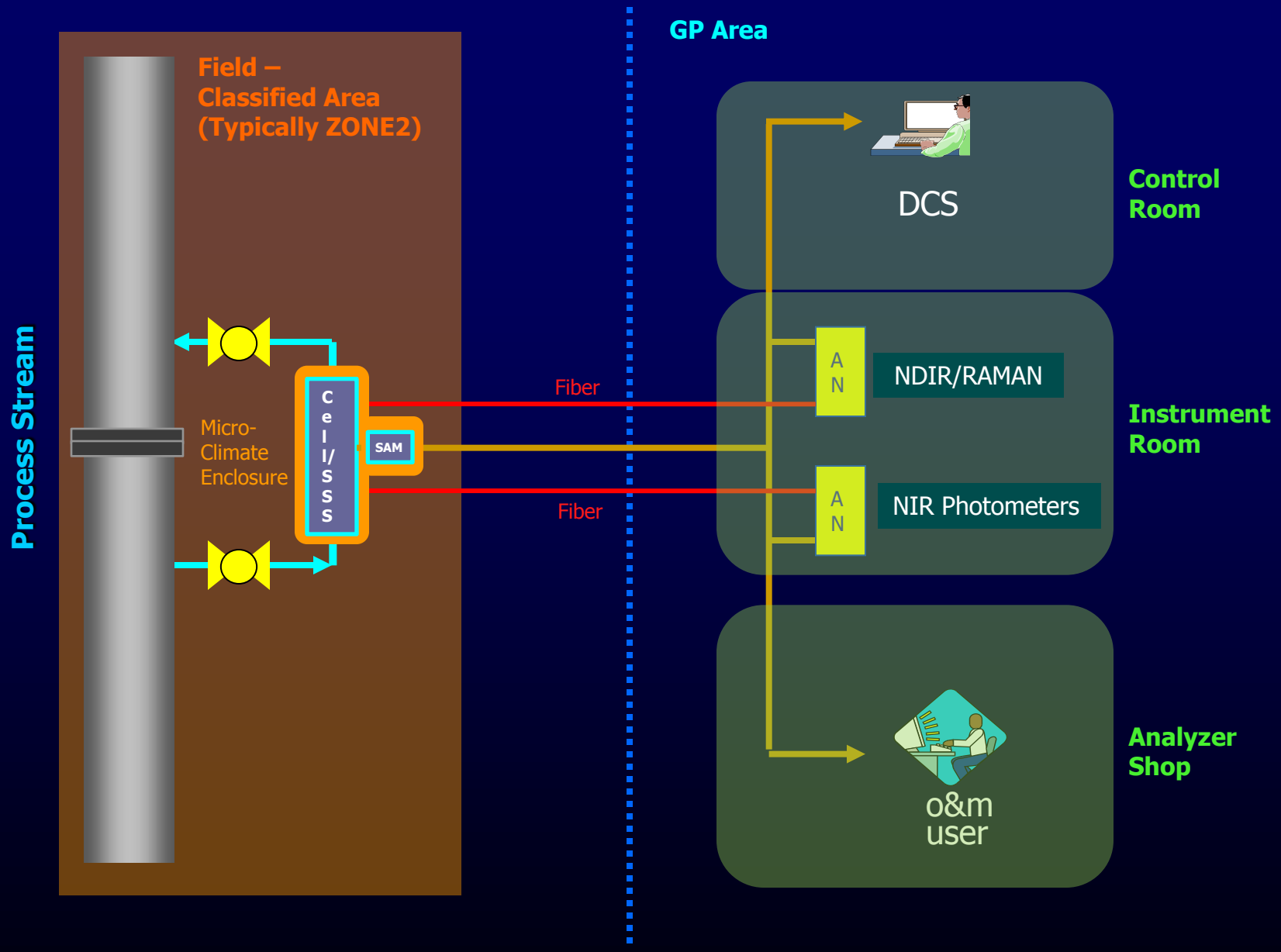
Failure

- Off-line Time
  Missed Opportunity
- Process Upset
  Loss of Production

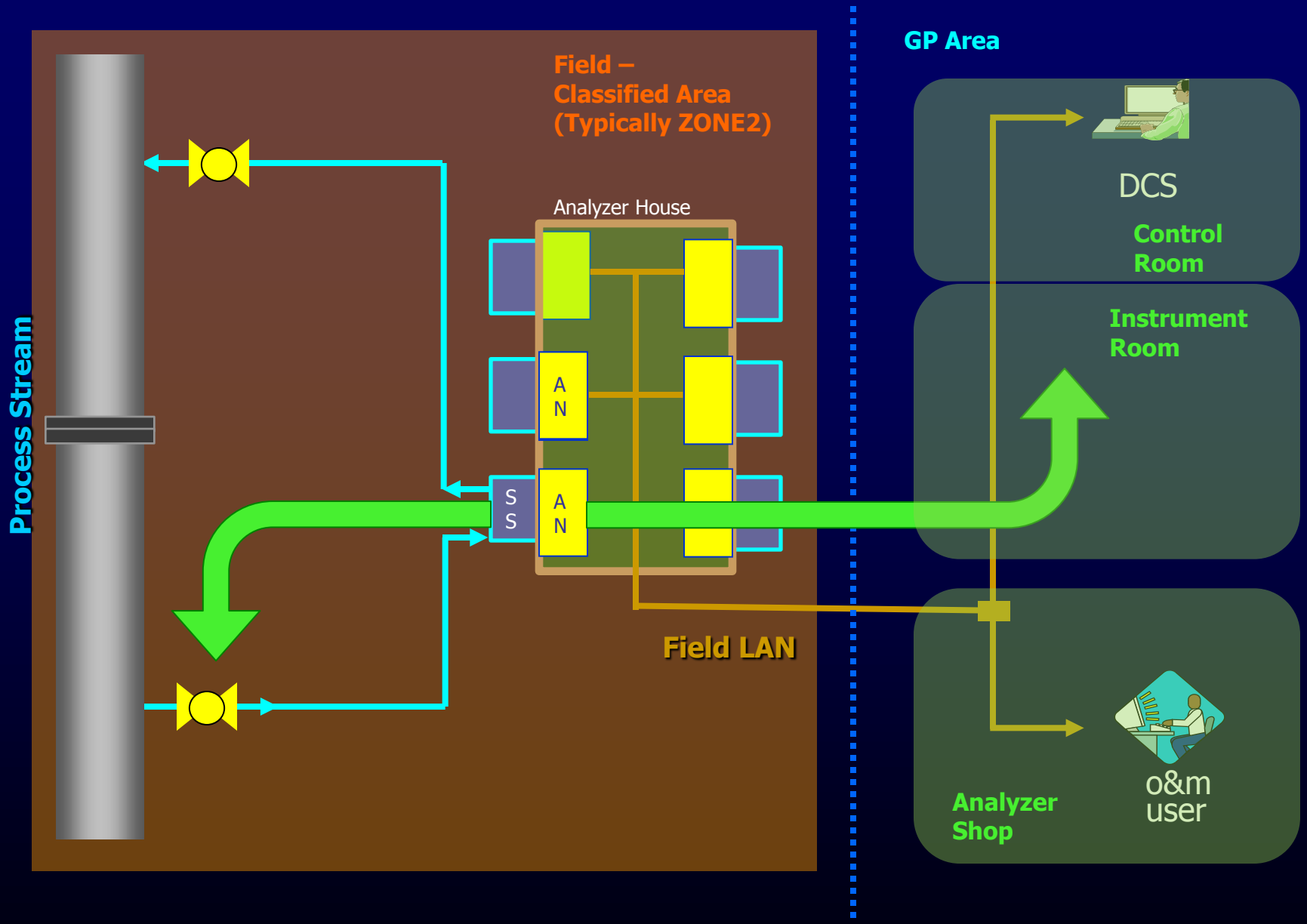
TCO Benefits of RAMAN/Smart Sampling System:

- Reliability
  * Push Validation down to Sampling System Level (75+% Analyzer Problems > Sampling System)
  * More Reliable Analyzer Hardware
- Reduce Sample System Hardware Costs
  * Minimize Sample Transport Costs
- Reduce Shelter Requirements
  * Remote probes
- No Consumables

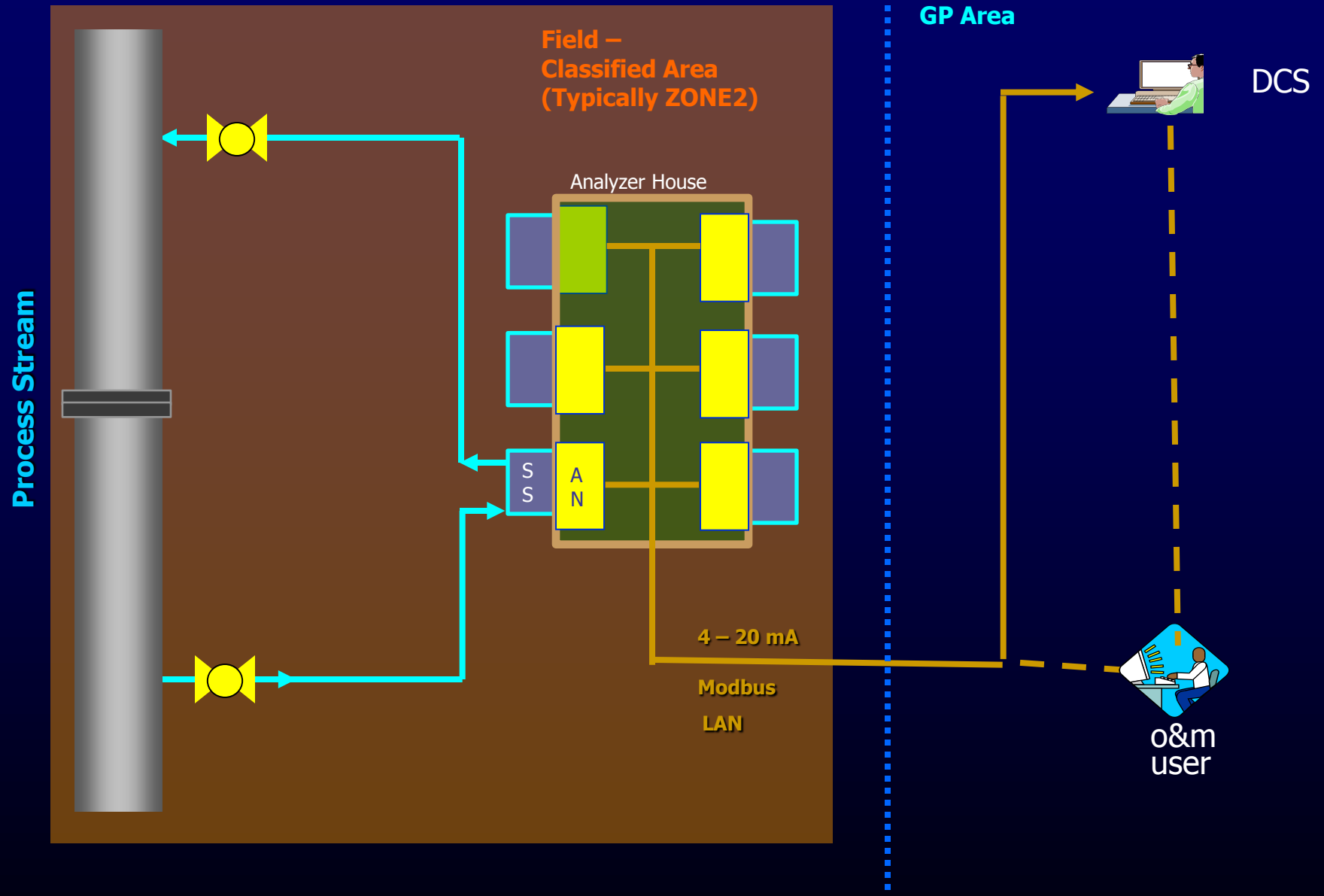
Enabling Topographical Changes: New/Greenfield Projects



Process Analytics Installation – New/Greenfields Projects



Simplified Topographical Diagram of a Process Analytics installation



Total Cost Of Ownership – A More Detailed Look

Build

- Analyzer $/ Spare Parts
- Sampling Systems
- Shelters/Panels
- Data System

- Sample Tap / Transport Lines
- Utilities (IA, Carrier Gases etc.)
- Power
- Cabling

Install

- Shelters/Panels

Own

- EQAT (Manpower)
- Consumables
  * Standards
  * Support Gases
- Spare Parts

Failure

- Off-line Time
  Missed Opportunity
- Process Upset
  Loss of Production

Sticker Shock Zone

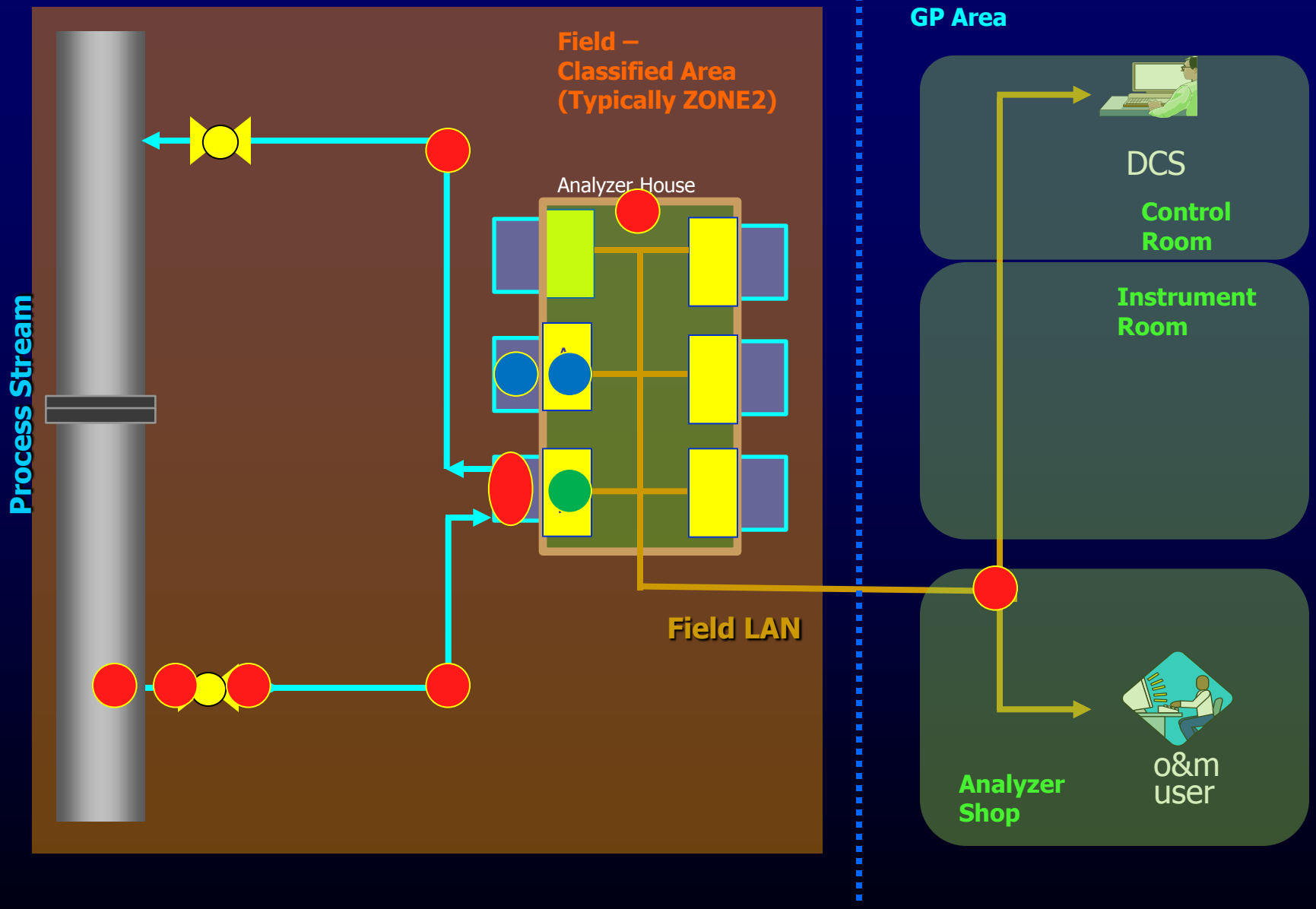
Sticker Shock Zone

Rational/ Big Picture View

Cost to Buy

Cost to Own/Operate

Connecting the DOTS



Spectroscopy as a Vehicle for TCO Optimization

Spectroscopic Options

- On-line RAMAN/NDIR Spectroscopy
  0.5% - 100%
- Trace Level TDLAS/DA
  1% - 0.1 PPM
- UltraTrace Spectroscopy as PPB Measurement Alternative
  100 PPB - 1 PPB

Why Spectroscopy?

- Inherently reliable technique
  (no of few moving parts)
- No or minimal consumables
  (no carrier gases, instrument air)
- Remote Sampling
  Uncouple the sampling interface from the analyzer proper

Total Cost of Ownership

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Install

- Shelters/Panels
- Hookups :
  Utilities, Power, Cabling, Sampling Systems
- Start-up & Commissioning

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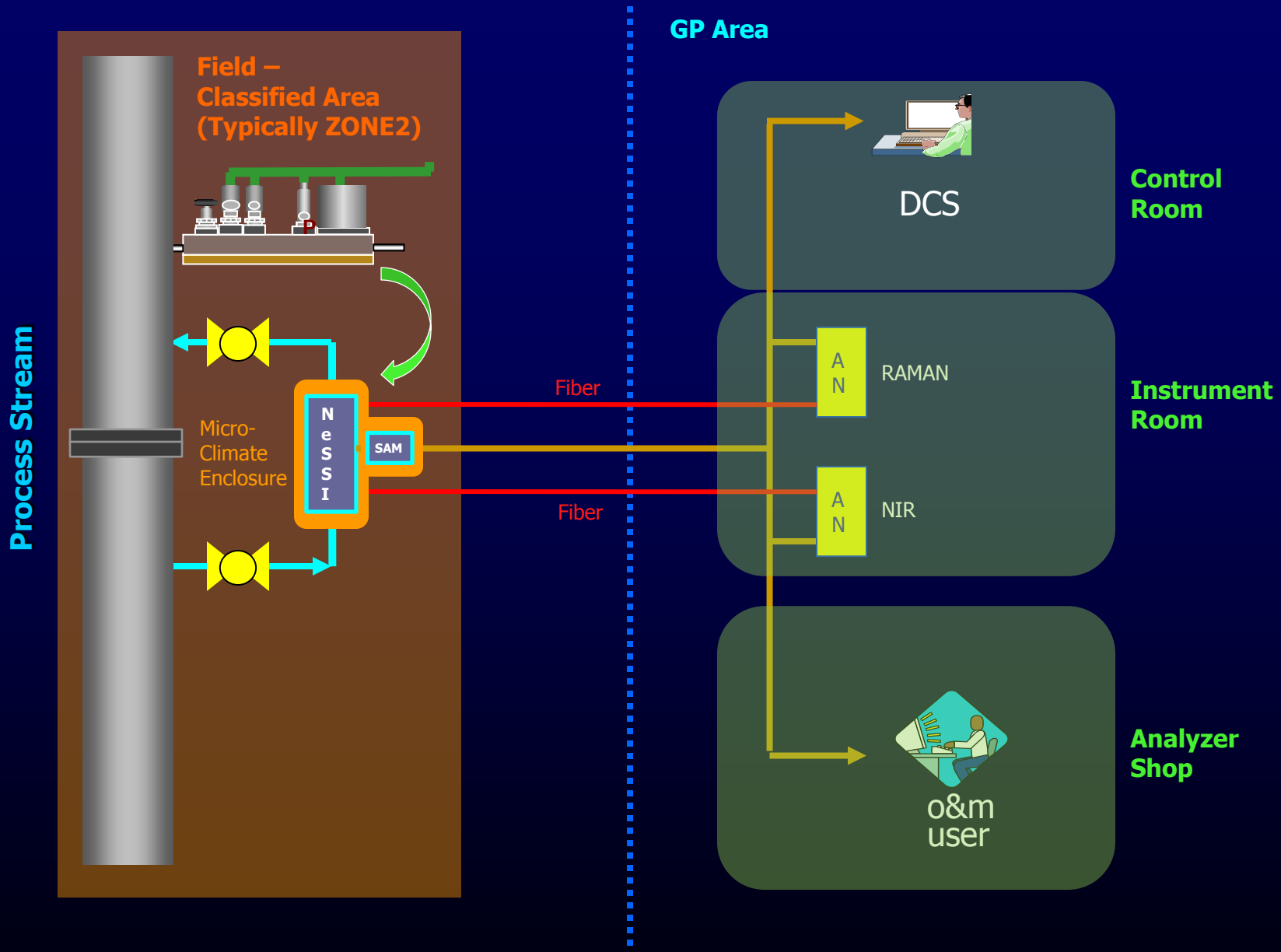
NESSI BENEFITS IN TCO OPTIMIZATION

NeSSI Enabled Spectroscopy/MA Process Analytics Topography



TCO Benefits of RAMAN/Smart Sampling System

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  Missed Opportunity
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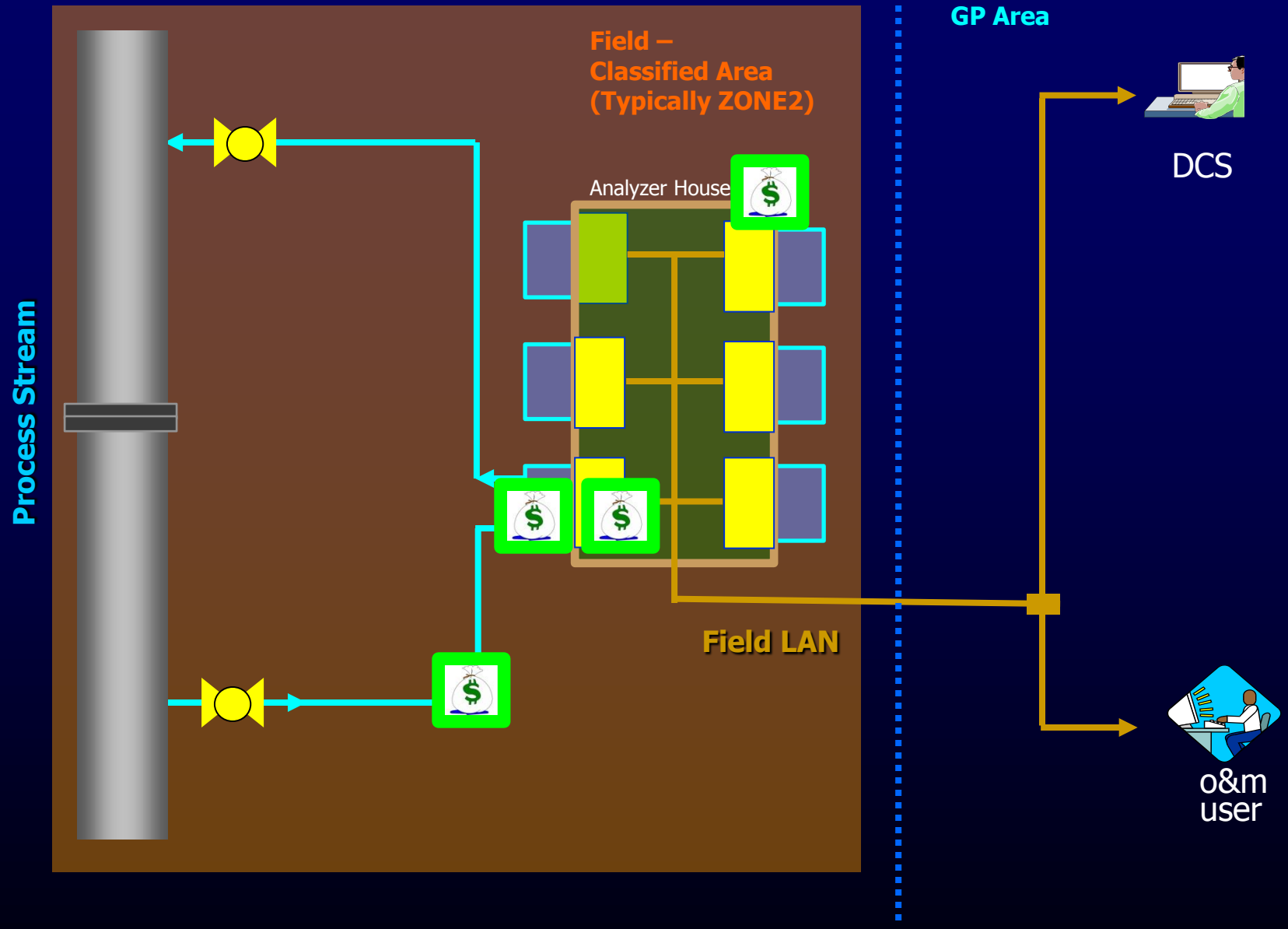
  Loss of Production

TCO Benefits of RAMAN/Smart Sampling System:

- Reliability
  * Push Validation down to Sampling System Level (75+% Analyzer Problems > Sampling System)
  * More Reliable Analyzer Hardware
- Reduce Sample System Hardware Costs
  * Minimize Sample Transport Costs
- Reduce Shelter Requirements
  * Remote probes
- No Consumables

Today's Process Analytics Topographical View = PAT



Total Cost of Ownership

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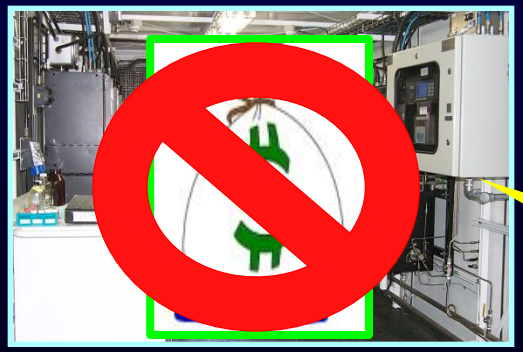
NESSI PLATFORM/MICRO-ANALYTICS/FIBER OPTICS BENEFITS IN TCO INITIATIVE

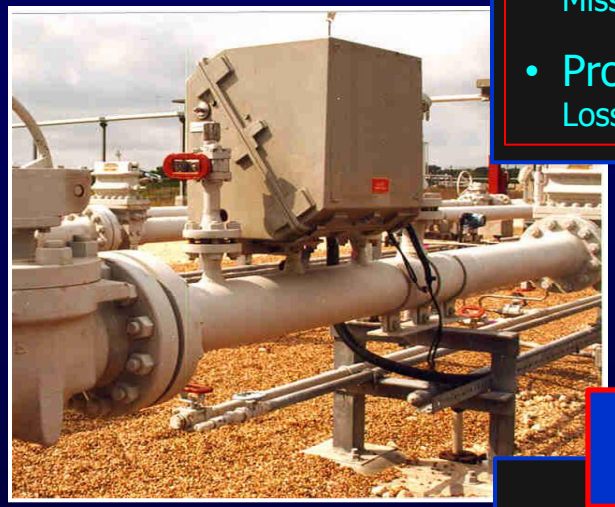
Total Cost of Ownership - Gen III Vision

Macro-House

Legacy SS



Macro-Analyzers



Courtesy of Dow Chemical, Freeport, Texas

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Intensive/Major Infrastructure Requirements → **Minimal Infrastructure Requirements**

Sample Handling:

- At line or close to line pressure
- Minimal Sample Conditioning
- No sample transport
- No sample return required
- Ports for calibration/validation
- Pressure and Temperature (and Flow Measurement)

Analyzer Sensor/Controller:

- Poles to tropics
- Does not require an analyzer shelter
- Intrinsically safe
- No moving parts (inherently reliable)

Sampling Probe:

- In the pipe or at the pipe
- High temp and flows
- Filtering of particulates
- Removal of condensables
- No sample take-off (in/ex situ sampling)

1. Communications to DCS

- Serial data links OPC, Modbus TCIP
- Future compatibility with wireless

2. Diagnostic LAN

- Separate and Firewalled from DCS and other plant devices/LANS
- Virtual Interface
- Full diagnostics/history
- Remote access/operations (off-site maintenance)