746th Test Squadron

Central Inertial & GPS Test Facility (CIGTF)

Automated GPS Simulation
Improving the Test Process
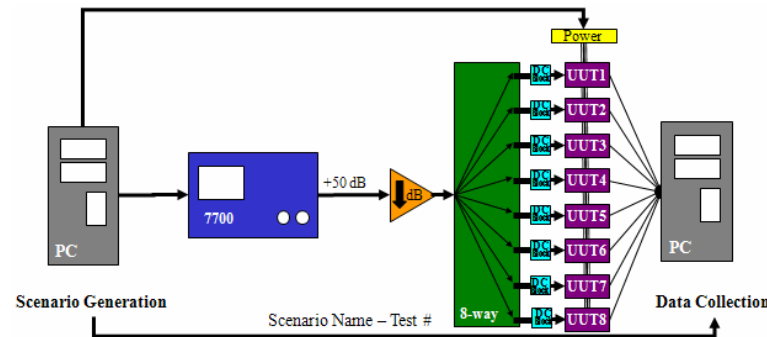
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Ben Gerten - PreTalen

Innovate - Execute - Excel

Introduction

- 746th Test Squadron Capabilities
- Navigation Test and Evaluation Laboratory (NavTEL) Capabilities
- Conventional Test Process
- Automated Test Process
  - Components
  - Flow & Layout
  - Receiver Support
- Automated Test Process Example
- Future Applications

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746th Test Squadron

Central Inertial & GPS Test Facility (CIGTF)

- **Premier Facility for System and Component Level Testing**
  - Missile Guidance and Control Systems
  - Inertial Navigation Systems (INS)
  - Global Positioning System (GPS) Receivers
  - Embedded GPS/INS (EGI) Navigation Systems
  - Systems Integration
  - Pointing and Tracking Systems
    :
  - Joint UAV Testing
- **Laboratory Tests Target Variables Prior to Field Testing**
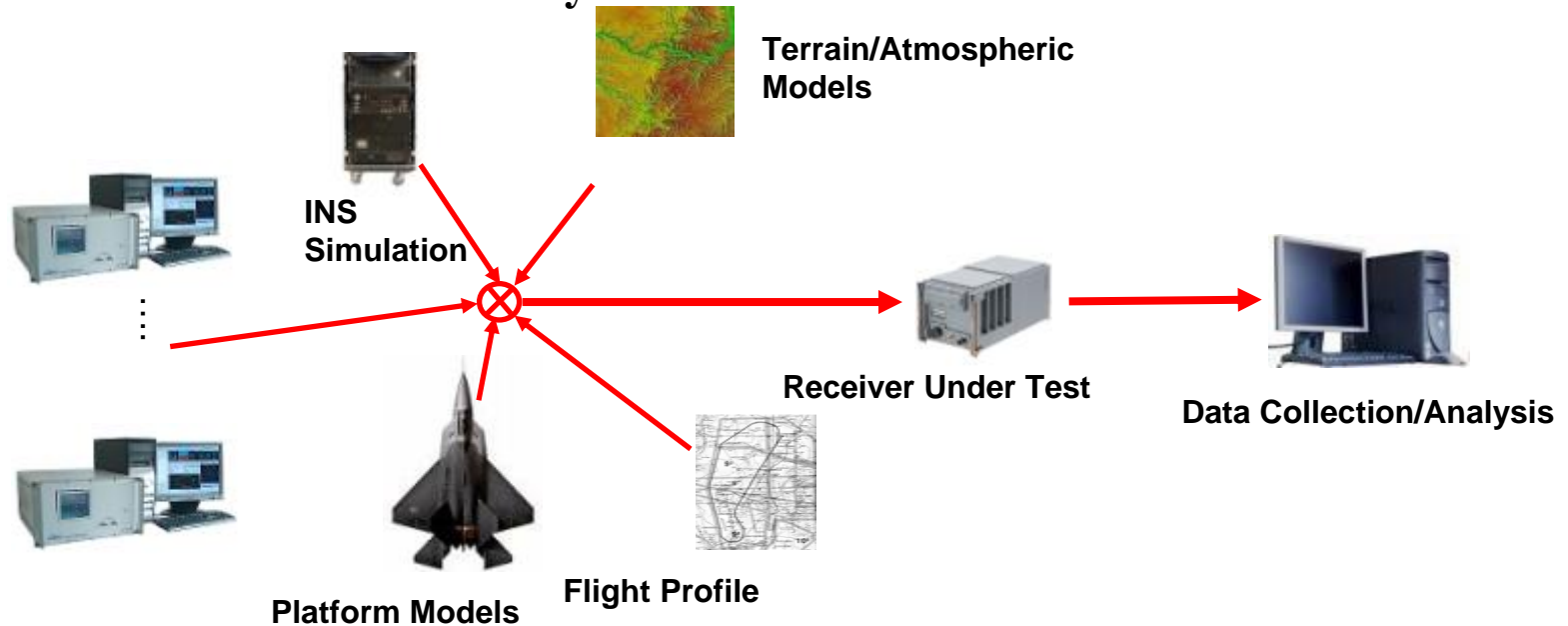- **Reference and Field Tests Verify Lab Results**

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NavTEL

GPS Receiver & EGI System Simulation Test

Terrain/Atmospheric Models

INS Simulation

Receiver Under Test

Data Collection/Analysis

Platform Models

Flight Profile

Navigation Test & Evaluation Laboratory **(NavTEL)**

 - Hardware-in-the-Loop Design
 - Trajectories (Real & Simulated Using AGI's STK)
 - Models: Scenario Dependent (Sensors & Control)
 - GPS Simulators (Spirent GSS 7700) *Modern Signals*
 - EGI Simulator (Spirent SimInertial)
 - Interference Signal Generators (Jammers)
 - Wave Front Simulators (Multi-Element Antenna Test)

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Conventional Methodology

- ## Spirent GSS7700 Simulator
  - Setup individual scenarios
  - User needs to be present to start new scenarios

- ## DOS based PC/104 Data Acquisition System (DAS)
  - Limited number of receivers
  - Use of removable media for data and Operating System
    - Must be off to access data
    - Must be reloaded whenever media is cleared
    - Must be reconfigured every time a hardware change is made
  - User needs to be present to record new data set

Conventional Process

Spirent GSS7700 GPS Simulator

PC/104 Data Acquisition System (DAS) for Receiver Collection and Control

```
DOS>
DOS> cd Navix
DOS> dir
DOS> dfkjdfkskfk,
ksfkfjd, lfjksdfkd
DOS>
```
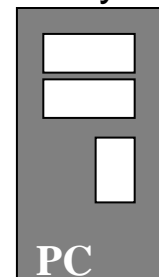
DOS Prompt

GPS
RF Signal

Disk

Unit Under Test (UUT):
GPS/INS Receivers

Analysis

PC

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Motivation

- Control large numbers of receivers

- Data collection from large numbers of receivers

- Data transfer without affecting data collection

- Parametric Analysis – Characterize GPS Receivers
  - Perform Design of Experiments (DOE) on variables
  - Automated scenario loading
  - Automated data collection and analysis

Motivation Cont…

- Simulation Analysis – Recreate Field Test Events
  - Read in motion files and create MOD files to create the correct signal's characteristics
  - Create a software model that can be used to describe a receivers behavior

- **Solution: Remove the operator**
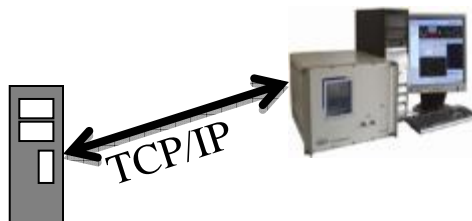 - "Human-*on*-the-loop" –not in it

Automated Components

- MOCHA

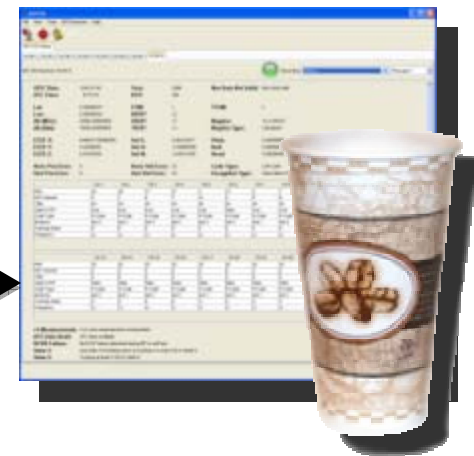- SPIDAR

- SimRemote

TCP/IP

- EASI

MOCHA

- Multiple Operation Central Host Application (MOCHA)
  - Utilizes multiple Quatech Serial Device Servers
  - Seamless Connectivity
  - Seamless Data Collection
  - Real-Time Monitoring
  - Quick Initialization
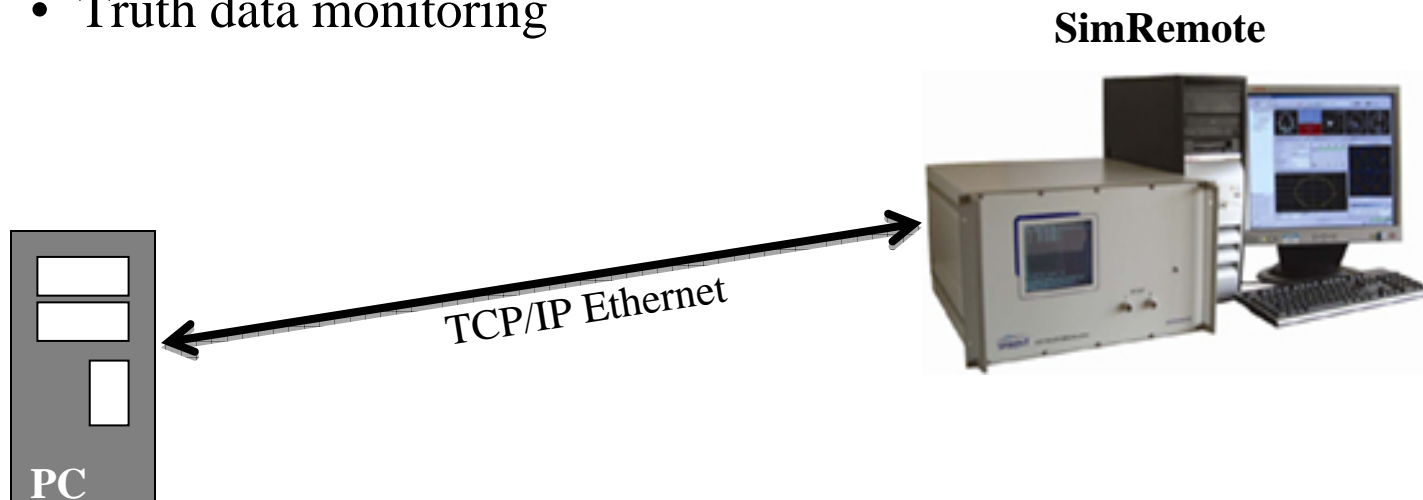 - Remote Scripting

MOCHA

Serial Device Server

SimRemote

- SimRemote
  - Extension of SimGEN software
  - Remote interface for Spirent Simulator control
  - Provides
    - Automated scenario loading
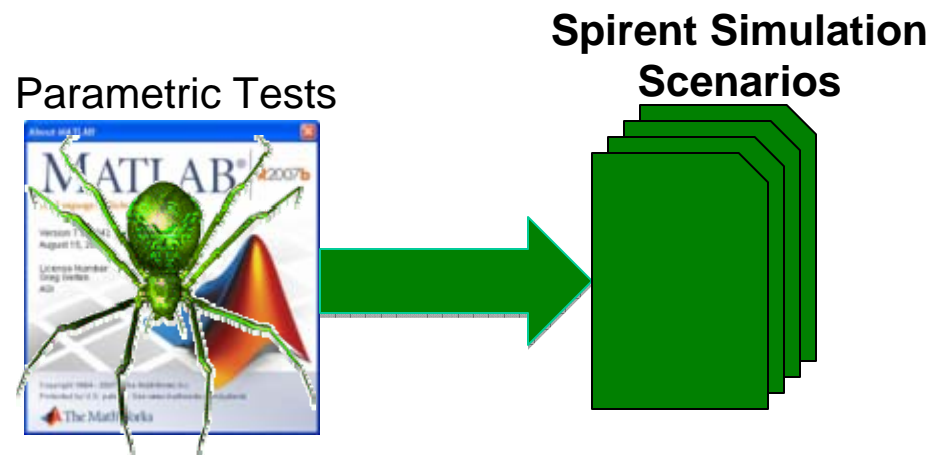   - Truth data monitoring

SimRemote

PC

TCP/IP Ethernet

SPIDAR

- ## SPIDAR

  - ### MATLAB based script

    - Easy to modify for new tests

  - ### Generates Spirent test scenarios

  - ### Allows parametric testing of multiple GPS variables

Parametric Tests

Spirent Simulation Scenarios

EASI

- Easy Array Software Interface (EASI)
  - Glue Program for MOCHA and SimRemote
  - Digests Spirent scenarios
  - Records MOCHA summary data
  - Records simulator truth data

EASI

MOCHA

SimRemote

Process Flow Chart

Parametric Runs

Pretalen's Spirent Data Generator (SPIDAR)

Scenario lists

Pretalen's easy array software interface (EASI)

Scenario data
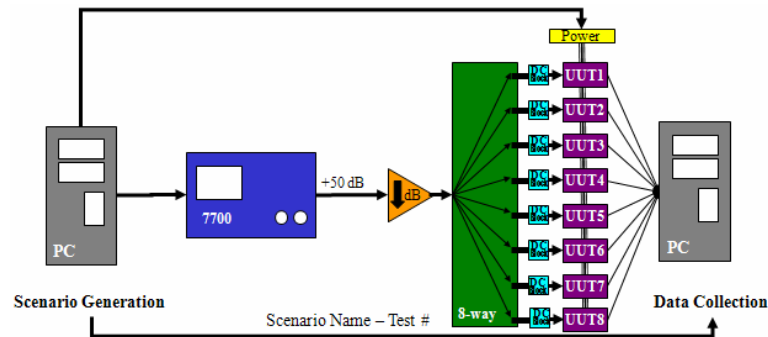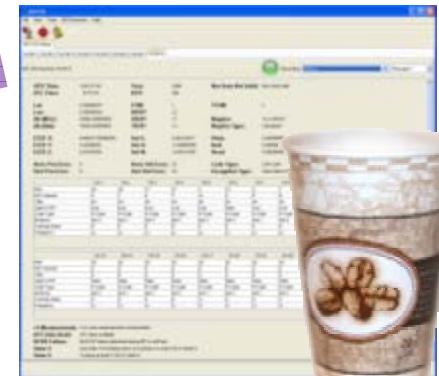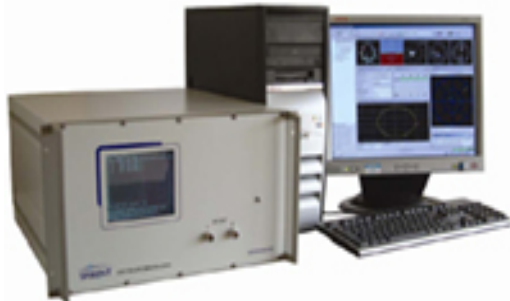
SimRemote commands

Receiver Inputs

SimGEN / Simulator

746 TS's receiver interface MOCHA

Initialization

RF

IS-GPS-153 data

Receiver Test Array (1-8 receivers)

Scenario Generation

7700

+50 dB

dB

Power

UUT1
UUT2
UUT3
UUT4
UUT5
UUT6
UUT7
UUT8
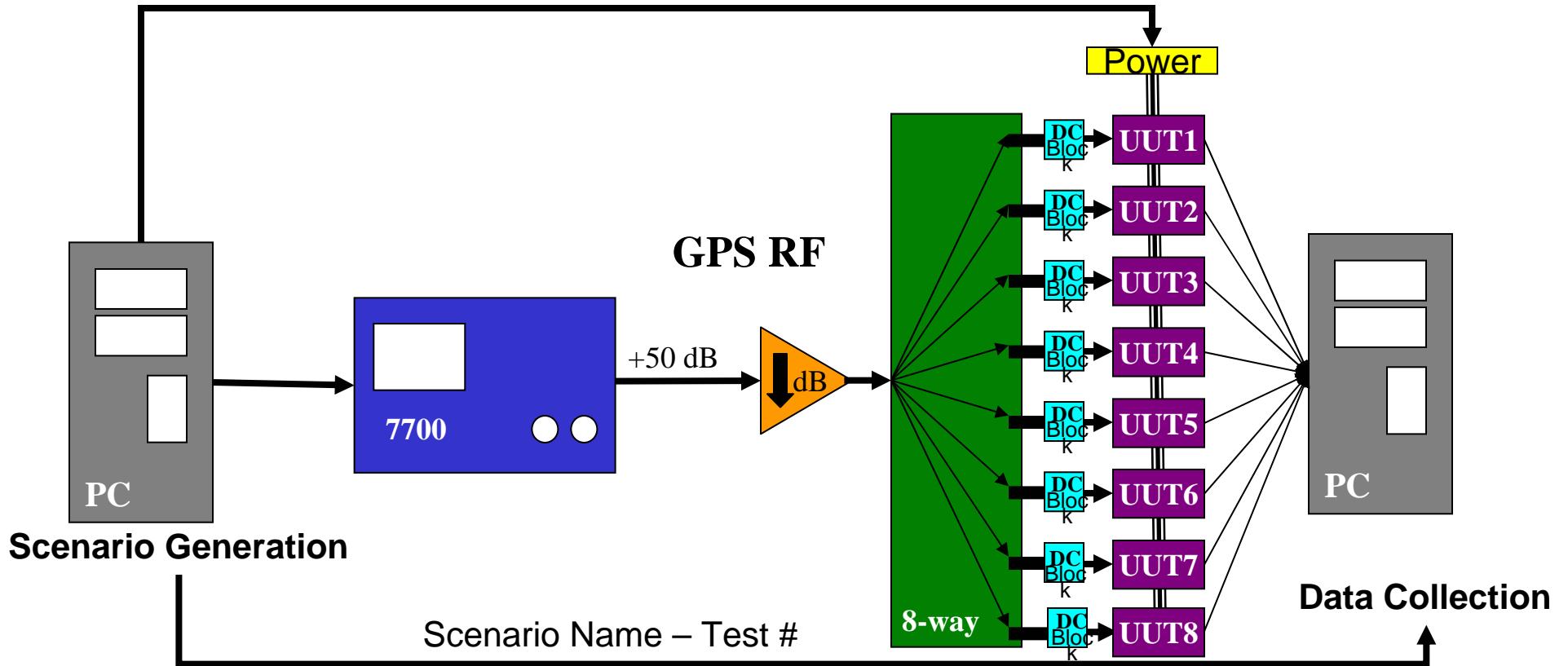
8-way

PC

Scenario Name – Test #

Data Collection

PC

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Process Layout

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Receiver Support

- Communication I/O Standards
- Output Data (from the receiver)
  - Used for real time display
  - Recorded for post-processing and analysis
- Input Data (sent to the receiver)
  - MOCHA sends commands to receivers with this data
    - Code type to track
    - Initialize position
    - etc…

Supported Receivers

- ## MOCHA modules currently support:
  - Military (ICD-GPS-153 on RS-232 / RS-422)
    - PLGR, DAGR, GB-GRAM…
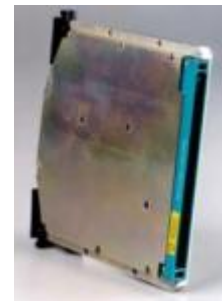 - Civilian
    - Javad Receivers
    - NMEA data only

Future Receiver Support

- MOCHA modules are being developed to support:
  - Military Receivers
    - MAGR, MAGRU, MAGR2K, R3A(046)
    - Force 5, GEM III,   GEM IV …
  - Civilian Receivers
    - Garmin V, üblox, Ashtech Z…

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Automated Test Process Example

SPIDAR: generates 500 scenarios and a list of scenarios
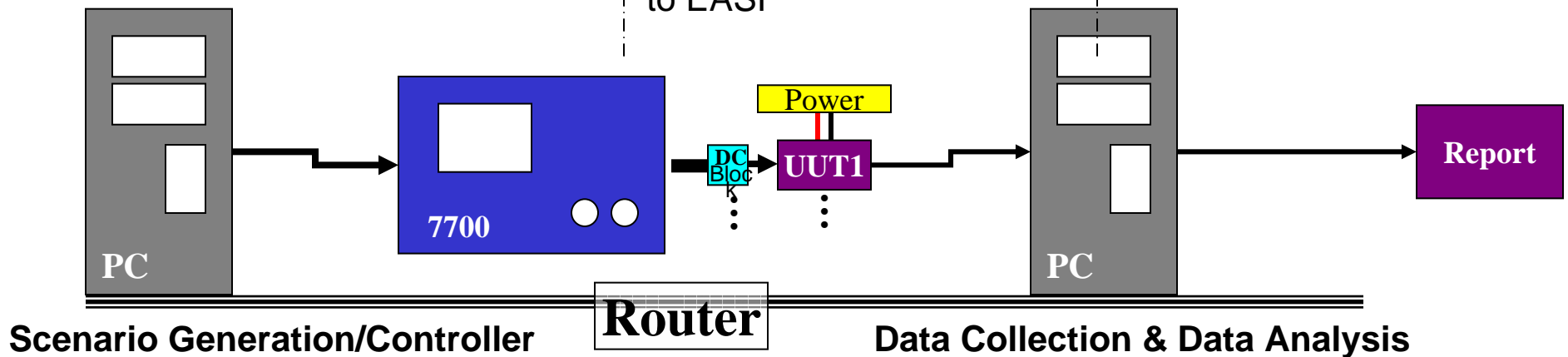
EASI (Control)/SimRemote Software
- Read File Listing Scenarios
- Initialize Rcvr / Send Run name & #
- Arm scenario / Command to Start
- Scenario ends - increment & repeat
- Set thresholds for events
- Compare data & write summary report

SimRemote: GPS Simulator
- Start Simulation
- Runs until running scenario is complete
- Wait for EASI to send next scenario
- Sends real-time truth data to EASI

MOCHA: Data Collection S/W
- Collects raw receiver data
- Read msgs 3,4,5040
- Sends real-time performance data to EASI

PC

7700

Power

DC Block

UUT1

PC

Report

Scenario Generation/Controller

Router

Data Collection & Data Analysis

Example Cont…

- Ran 500 scenarios each between 5-15 minutes long
- > 66 hours of GPS simulations
- Completed on 8 DAGRS in < 3 days

Future Applications

- ## Advantages of Automated Test Process
  - Support multitude of receivers

  - Intuitive/Simple GUI monitoring & control

  - Quick access to multiple receiver functions

- ## Applications of Automated Test Process
  - GPS End-to-End Testing

  - Satellite Reference Station

  - Dynamic Flight/Van Testing

Summary

- 746th Test Squadron Capabilities

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  - Flow & Layout
  - Receiver Support

- Automated Test Process Example

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Questions?