VTI Instruments

Challenges and Solutions to RFIU Design

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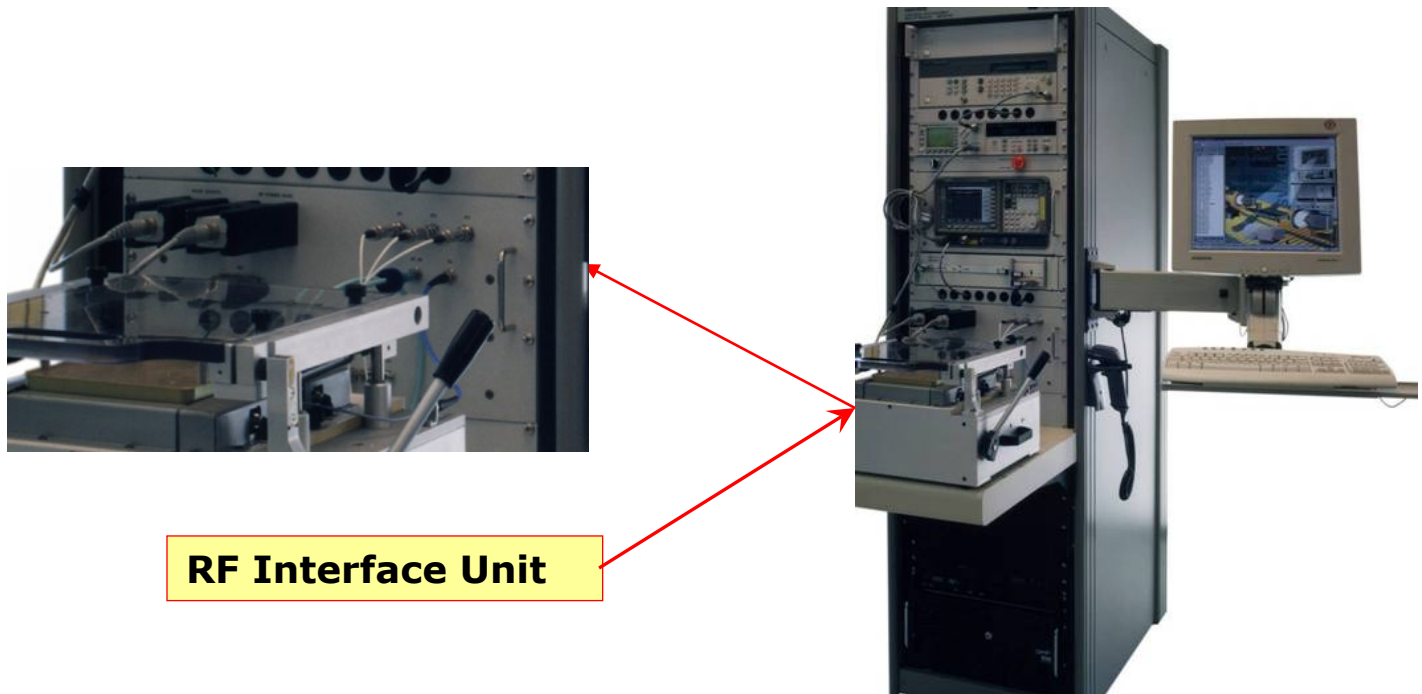
What is an RF Interface Unit (RFIU)?

The RFIU links the Device Under Test (DUT) to test and measurement instrumentation such as spectrum analyzers, synthesizers and power meters.
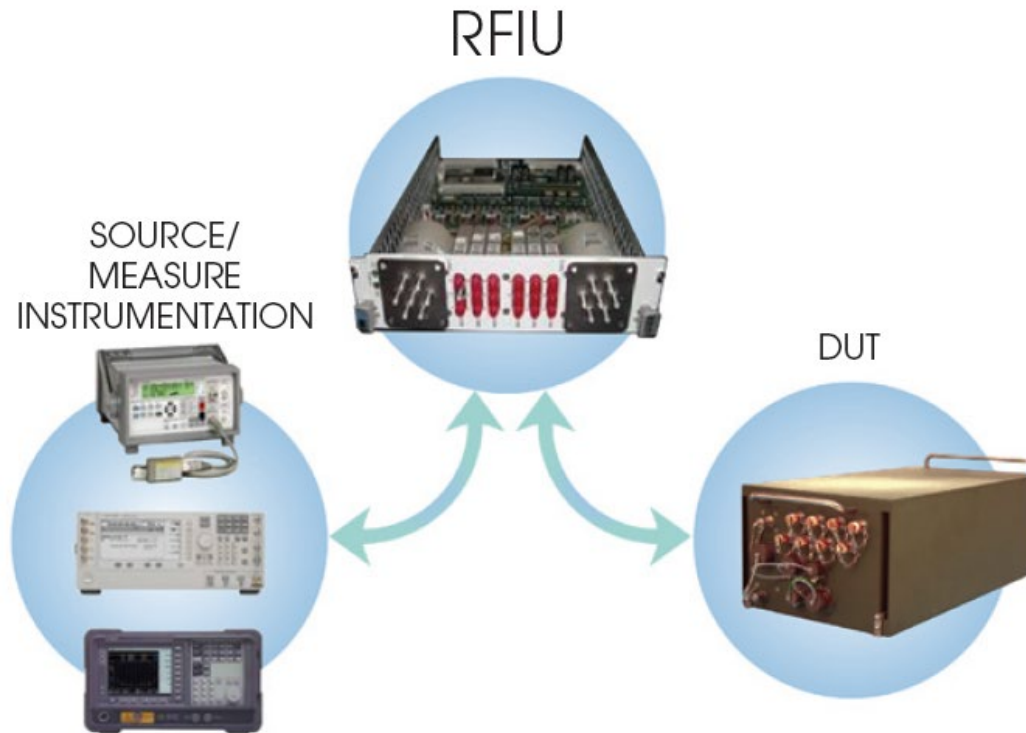
ATE System with RFIU

- An RFIU is almost always custom (unique to the DUT).
- It allows the signals to be routed, attenuated, combined, split, filtered, and/or amplified.
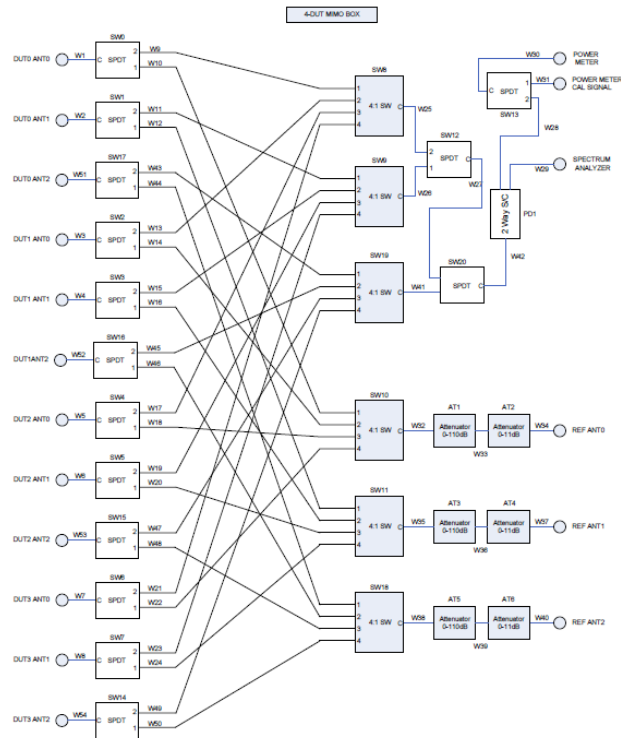

RF Interface Unit

What types of customers to target?

- Anybody testing a high mix of products on one tester, or volume production of devices that have high frequency signal components up to 50 GHz.

- Many different applications where routing and conditioning RF/Microwave signals is required as part of an overall system design.
  - Includes relays, attenuators, splitters, combiners, filters and other programmable and passive components.

- Any one of your customers that are looking to buy either your RF/Microwave components, or your RF test equipment such as network analyzers, spectrum analyzers, power meters, etc.

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Primary application areas include:

- Satellite

- Space

- Communications

- Mil/Aero

- Mobile radios

- Cellular

- Antenna systems

- Wireless peripherals, Bluetooth

- Broadband wireless transceivers

The Challenge with RFIU Development

Turning a Signal
Routing/Distribution Design

Into

A <u>Fielded</u> and <u>Supportable</u>
RF Interface Unit

The Real Costs of Custom-Developed RFIUs

Problem
RFIU subsystems can become a "project with a project", requiring multiple engineering disciplines
• RF Engineering for Design and Check Out
• Electrical Engineering for Control Design
• Mechanical Engineering for Box Design, Cooling, and Lay-out
• Software Engineering for Soft Front Panel, Driver, Command Set, and Path Definitions

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The Real Costs of Custom-Developed RFIUs

VTI
Instruments

Problem
"Project within a project" introduces potential for significant schedule slippage
In-house RFIU designs are often poorly documented, if at all, and therefore supported from "Tribal Knowledge"
Overt as well as hidden costs can vastly exceed expectations and budgets

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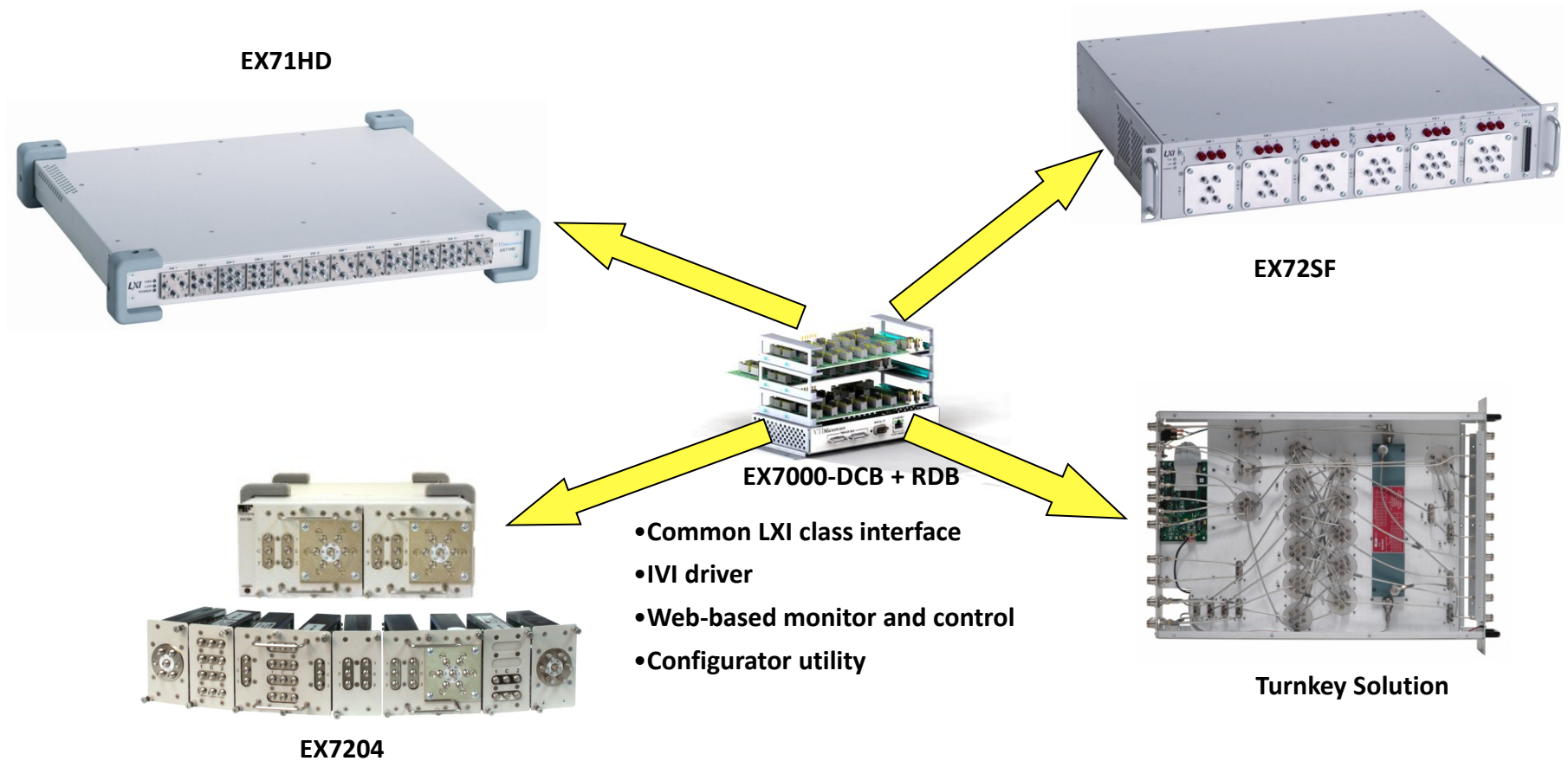# How Does VTI Address These Challenges?
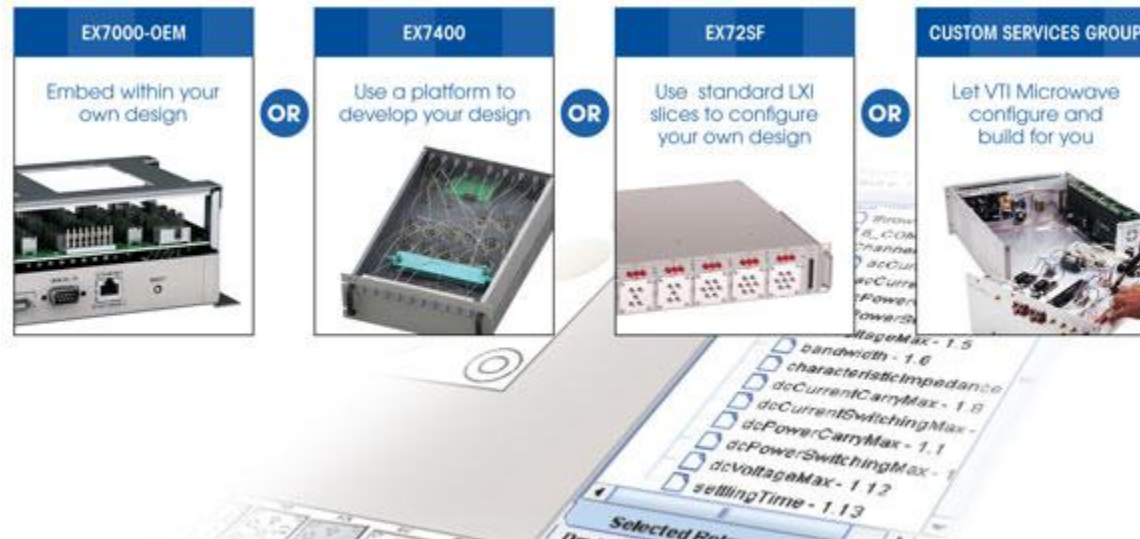
Products, tools, and services to partner in any phase of the customer's design

- The most diverse range of products for the RFIU application space
- Powerful COTS control interface means reconfiguration in less time.
- Support that costs less.
- Software development completed out of the box!!
- COTS solutions for Custom Requirements

EX7000 RFIU Solution Platform

Not simply four products – but one product deployed in multiple ways

EX71HD

EX72SF

EX7000-DCB + RDB

- **Common LXI class interface**
- **IVI driver**
- **Web-based monitor and control**
- **Configurator utility**

EX7204

Turnkey Solution

The Core of Every EX7000 Product

- LXI-based Digital Control Board

- 72-channel Relay Driver Boards

- Embedded Device Configuration Files (DCF) stores/returns location and type of component installed in system

- Flexible coil control options for virtually any component type

- Tracking odometers for preventative maintenance

- Individual contact indicator lines provide feedback of contact state

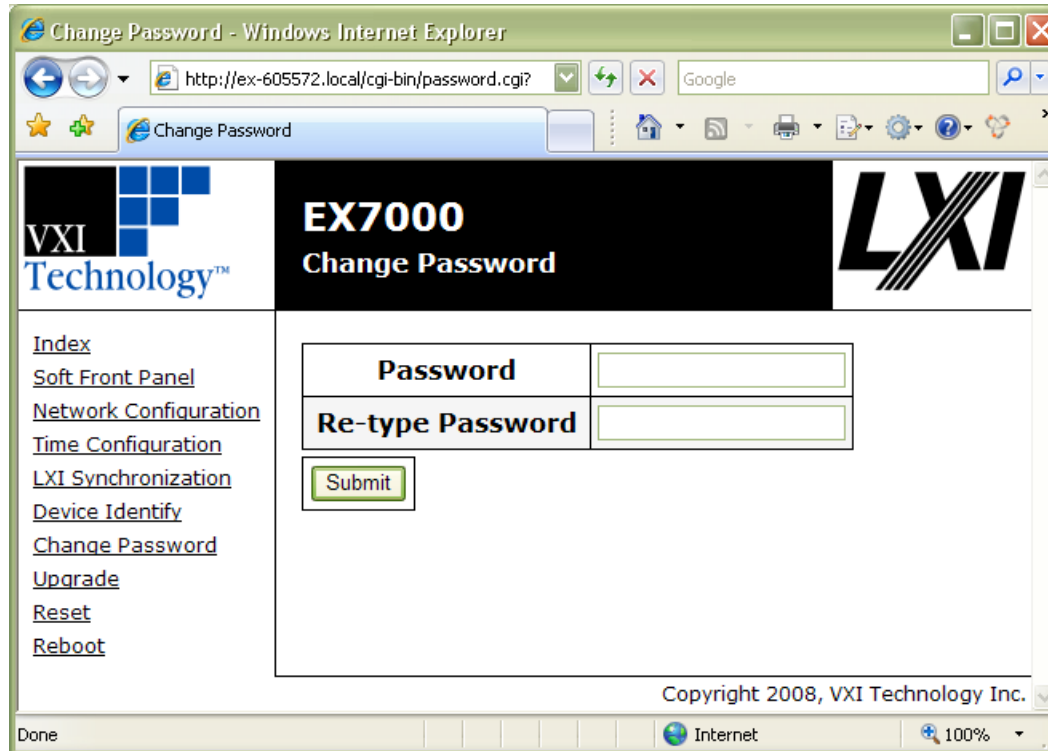- IVI driver

- Automatically generated GUI

Relay/Attenuator Driver Board
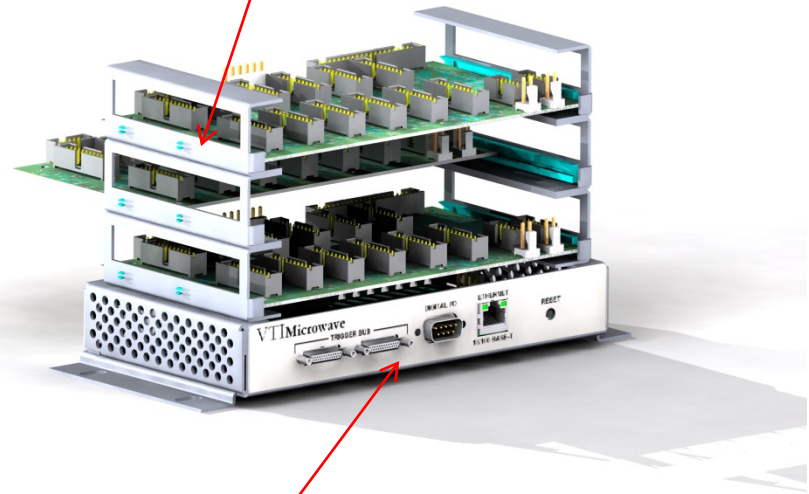
LAN/LXI Communications Interface

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EX7000 Soft Front Panel (SFP)

Complete LXI Interface for operation in todays standard test environments

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EX7000 Soft Front Panel (SFP)

- JAVA-based SFP pulls configuration file and populates custom GUI

- No programming required

- Accessible through web-browser

- Component specific information displayed

- Useful for troubleshooting, development, and "bench" control

"The RF guy doesn't have to be a SW guy"

September 2, 2020 | Slide 13

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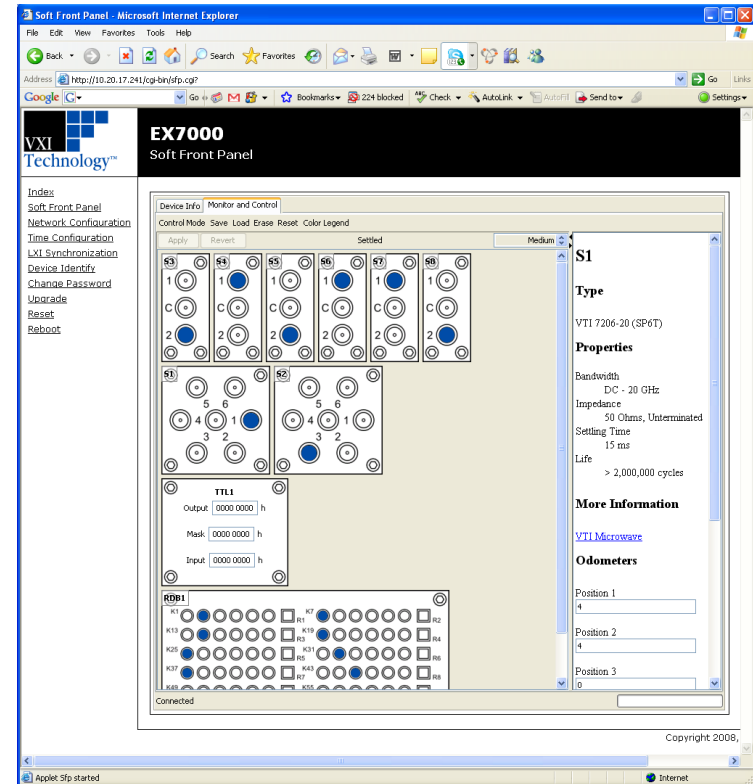
Built-in End-to-End Path Level Software Control

What relays do I need to close to connect DUT ANT0 to the Power Meter?
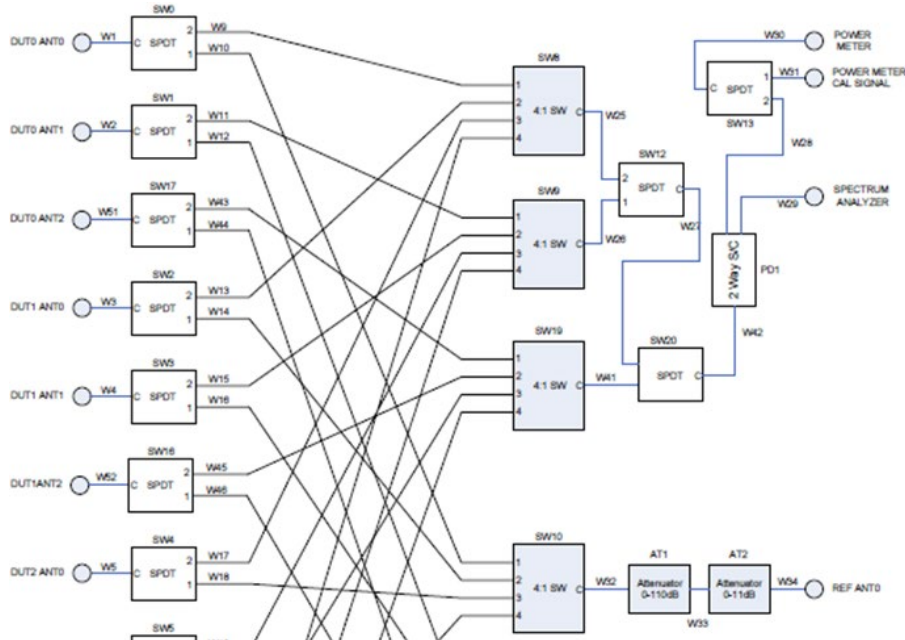
"The SW guy doesn't have to be an RF guy"

PROGRAMMING USING THE EX7000

```
IviSwitch_Connect (RFIU_Session, DUT_ANT0, PWR_MTR);
```

RF / Microwave Switching – EX7000

OEM INTERFACE

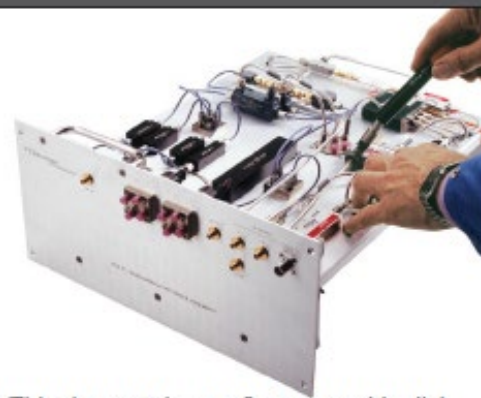Embed within your own design

DEVELOPMENT CHASSIS

Use a platform to develop your design

STANDARD MODULAR PRODUCTS

Use standard LXI slices to configure your own design

CUSTOM SERVICES GROUP

Let VTI Instruments configure and build for you

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Standard Products

- ## Modular products
  - ### VXI – SMP
  - ### LXI
  - ### PXI

Standard Products

SM7000 (SMIP-VXI)

Up to 40 GHZDC to 26.5 GHz
The First Modular VXI Microwave Switch on the Market
Single slot and dual slot
Building Blocks Range from Dual SPDT Relays to SP6T Relays,
Transfer Switches and Relay Drivers
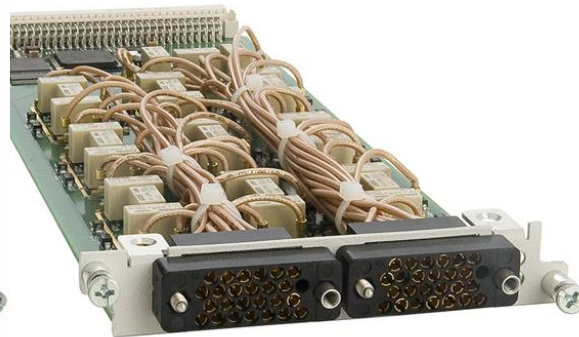Microwave Building Blocks

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Standard Products

EX1200-7000 (LXI)

Switch signals from DC to 26.5 GHz
Building blocks range from dual SPDT relays to SP6T relays, transfer switches and relay drivers
Microwave building blocks are "pluggable" from the front
Mix and match with any other eX1200 plug-in modules

Standard Products

SMX 7000 (PXIe)

Switch signals from DC to 26.5 GHz

Building blocks range from dual SPDT relays to SP6T relays, transfer switches and relay drivers

Microwave building blocks are "pluggable" from the front

Mix and match with any other PXIe plug-in modules

Standard Products

- ## Stand alone (LXI)
  - ### EX7204
  - ### EX71HD
  - ### EX72SF
  - ### EX7*n*CF

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Standard Products

- ## Stand alone

  - **EX7204**
  - EX71HD
  - EX72SF
  - EX7*n*CF

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Standard Products

- ## Stand alone

  - ### EX7204

    - Modular implementation
    - Plug in carrier

Standard Products

- EX7204
- Plug in relays - allows you to configure system to match the application
  - Four plug in slots
  - Limited capability to include non-relay items (couplers, attenuators etc.)
  - No cabling, front panel mounted relays
  - Same controller across all chassis
  - Standard GUI / SFP control, built-in webpage
  - LXI/LAN and USB command and control options
  - Store up to 128 relay configurations for quick recall, including automatic power-up state

Standard Products

- ## Stand alone
  - EX7204
  - **EX71HD**
  - EX72SF
  - EX7*n*CF

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Standard Products

- ## EX71HD

- Plug in relays - allows you to configure system to match the application
- No cabling, front panel mounted relays
- Up to 12 building slots, dual SPDT, SP4T, SP6T, or transfer switch
- Compact1U footprint
- Store up to 128 relay configurations for quick recall, including automatic power-up state
- Define exclude lists to avoid setting an undesirable configuration
- Relay odometer tracks closures to facilitate preventative maintenance

Standard Products

- ## Stand alone
  - EX7204
  - EX71HD
  - **EX72SF**
  - EX7nCF

Standard Products

- **EX72SF**
- Plug in relays - allows you to configure system to match the application
- No cabling, front panel mounted relays
- Up to 6 SPDT and multiport high-performance building blocks in a 2U footprint
- Extended life and self-terminating options provide maximum design flexibility
- Store up to 128 relay configurations for quick recall, including automatic power-up state
- Relay odometer tracks closures to facilitate preventative maintenance

RELIABLE DATA   FIRST TIME   EVERY TIME

Standard Products

- ## Stand alone
  - EX7204
  - EX71HD
  - EX72SF
  - **EX7nCF**

Standard Products

- ## EX7nCF
- Any U-size to meet the requirements
- May add external cabling (limited interconnect)
- Any relay any configuration – loads, couplers, termination etc.
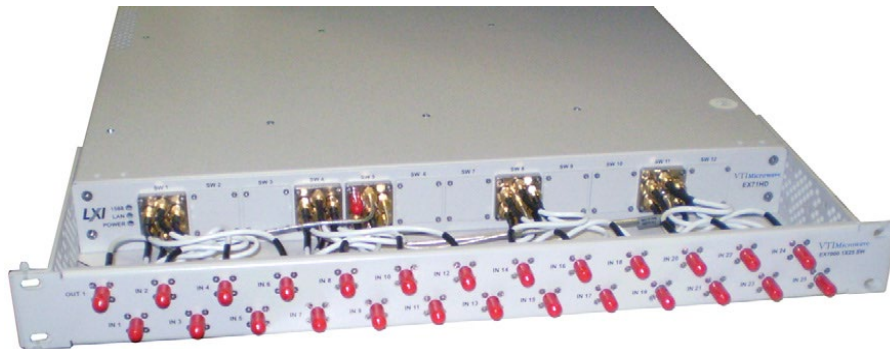
EX7000 Series

RF and Microwave Solutions

- Standard products

- Stand alone

- Modular solution (VXI, PXI and LXI)

❑ **Modified COTS (custom)**

Why a VTI developed custom RFIU?

Modular RFIU	Custom RFIU
Modular RFIU in any of the standard measurement platforms (VXI, PXI, LXI)	Custom RFIU designed per customers requirements
• Lower in cost	VTI manages cost for custom RFIU by using standard building blocks
• Easily configurable by changing or replacing relay modules	Custom solution is designed for a very specific need
• Cabling is external and located on the front	Cabling is contained within the enclosure ensuring maximum performance and reduces wiring error and simplifies connectivity
• Generally limited to relays and some basic uWave components	Can incorporate most any uWave component, relays, amplifiers, splitters, combiners, etc

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The Real Benefit of VTI-Developed RFIUs

Problem	VTI Solution
RFIU subsystems can become a "project with a project", requiring multiple engineering disciplines	Customer engineering team focuses on specifying needs rather than managing details
• RF Engineering for Design and Check Out	VTI's RF Engineering team designs and tests – full reports provided
• Electrical Engineering for Control Design	EX7000 Digital Control Board and Relay Driver Board provide standard, COTS control scheme
• Mechanical Engineering for Box Design, Cooling, and Lay-out	VTI's experience Mechanical Engineering team puts together complete 3D design for both mechanical and electrical placement -> NO SURPRISES
• Software Engineering for Soft Front Panel, Driver, Command Set, and Path Definitions	LXI-based EX7000 provides embedded soft front panel and device configuration. IVI driver provides industry standard interface with rich capabilities, including path-level control.

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The Real Benefit of VTI-Developed RFIUs

Problem	VTI Solution
"Project within a project" introduces potential for significant Schedule Slippage	VTI's program manager tracks internal and external milestones, communicates schedule status, and ensures delivery commitments are met.
In-house RFIU designs are often poorly documented, if at all, thus supported from "Tribal Knowledge"	EX7000 solutions are fully documented on the level of a piece of COTS test equipment. VTI builds each unit to our ISO quality standards – whether the first system or the 1000th.
Overt as well as hidden costs can vastly exceed expectations and budgets	EX7000 subsystems are quoted on a firm, fixed-price contract based on documented, agreed-upon requirements -> NO SURPRISES

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VTI – RF Signal Distribution

Integrated RF/Microwave Distribution Subsystems

- Full integration of signal distribution subsystems, build to print or design to spec
- Uses same digital communications and relay driver control as standard product
- Designed for ease of maintenance
- COTS solutions for custom requirements
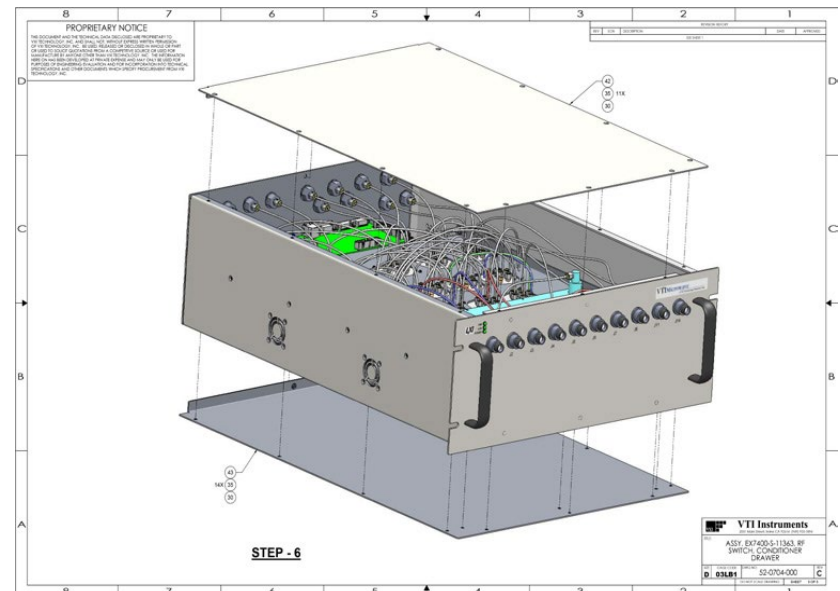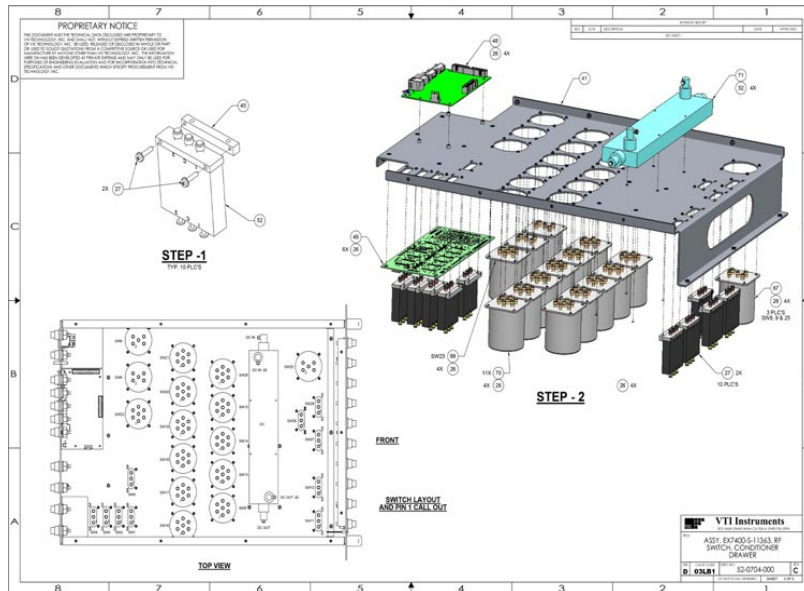- 3D modeling prior to build ensures maximum performance

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What do we deliver

- Complete documentation Package
  - System level Full RF performance characterization
  - Acceptance Test Procedure

Frequency (GHz)
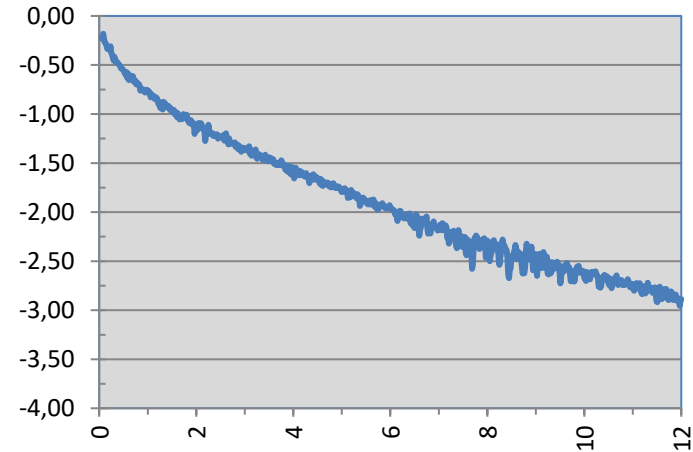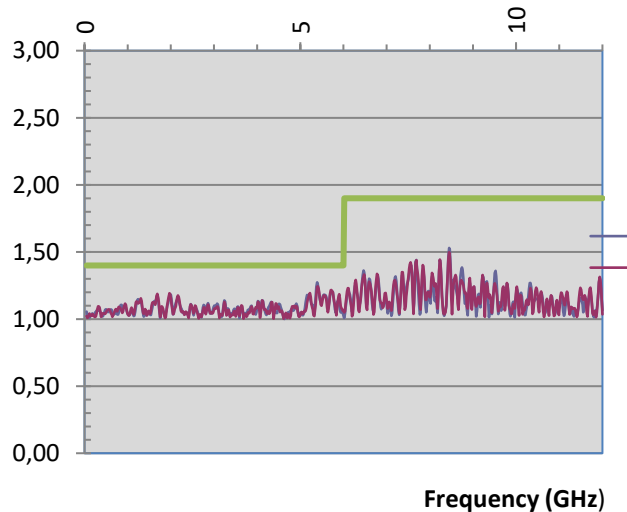
What do we deliver

- Complete documentation Package
  - Mechanical DWG (hard or soft copy)

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3D Modeling Reduces Risk

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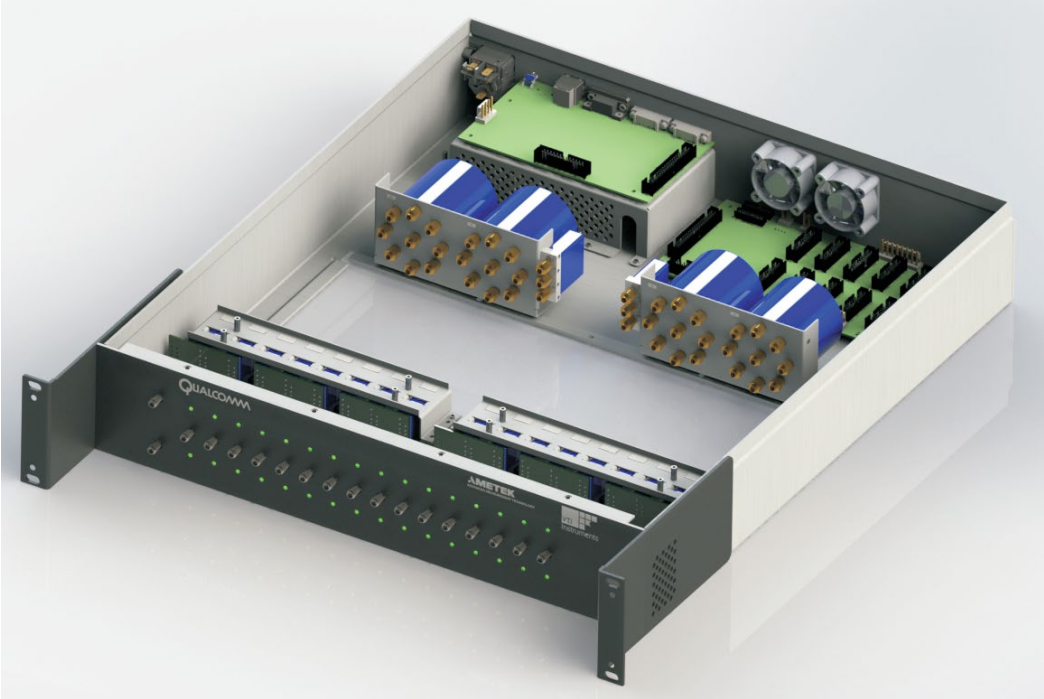
EX7000 Microwave switching solutions

Why we win

- Wide range of products and platforms
- High quality engineering and components
- Easy to use and low cost of ownership
- Engage / Understand / Deliver
- Provide a complete innovative technical solution
  - Mechanical implementation
  - Expected RF performance

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Harris Case Study

- Mill- Aerospace

  - # Harris
    - 12X12 Matrix full access
    - 4-5 chassis per year
    - 16 Chassis delivered
    - $65 K per chassis

  Reasons we won
    1. Engage
    2. Understand
    3. Deliver

Case Study – Harris Communications
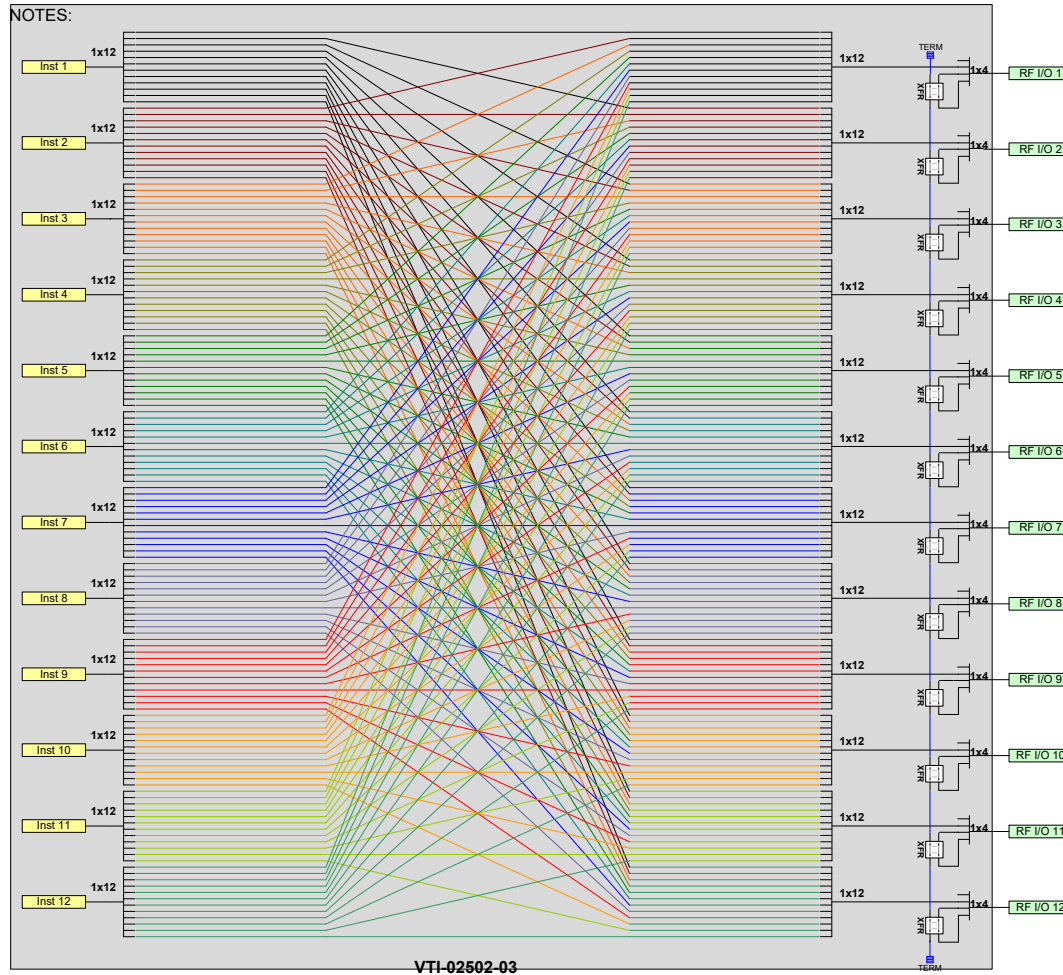
- 12 x 12 matrix
- Connect any of 12 instruments to any of 12 radio I/O ports
- Allow any radio to be connected to any radio
- >200 RF cables
- >200 relay drive lines
- Customer only interested in connecting inputs to outputs, opening/closing relays

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Optimally Designed for Maintainability and Performance

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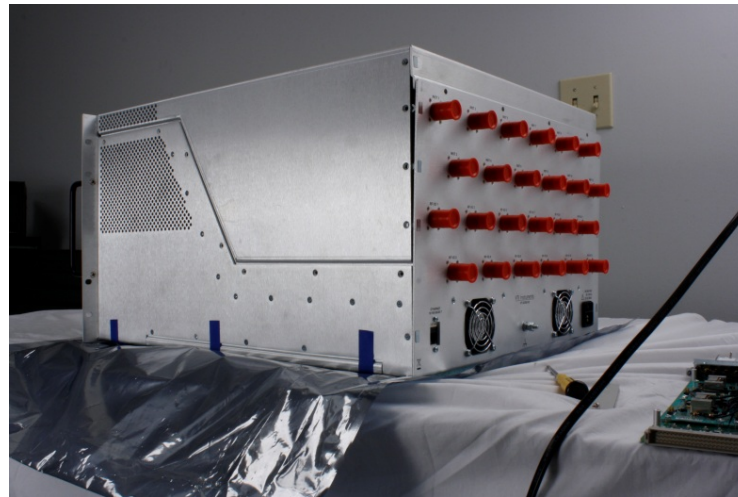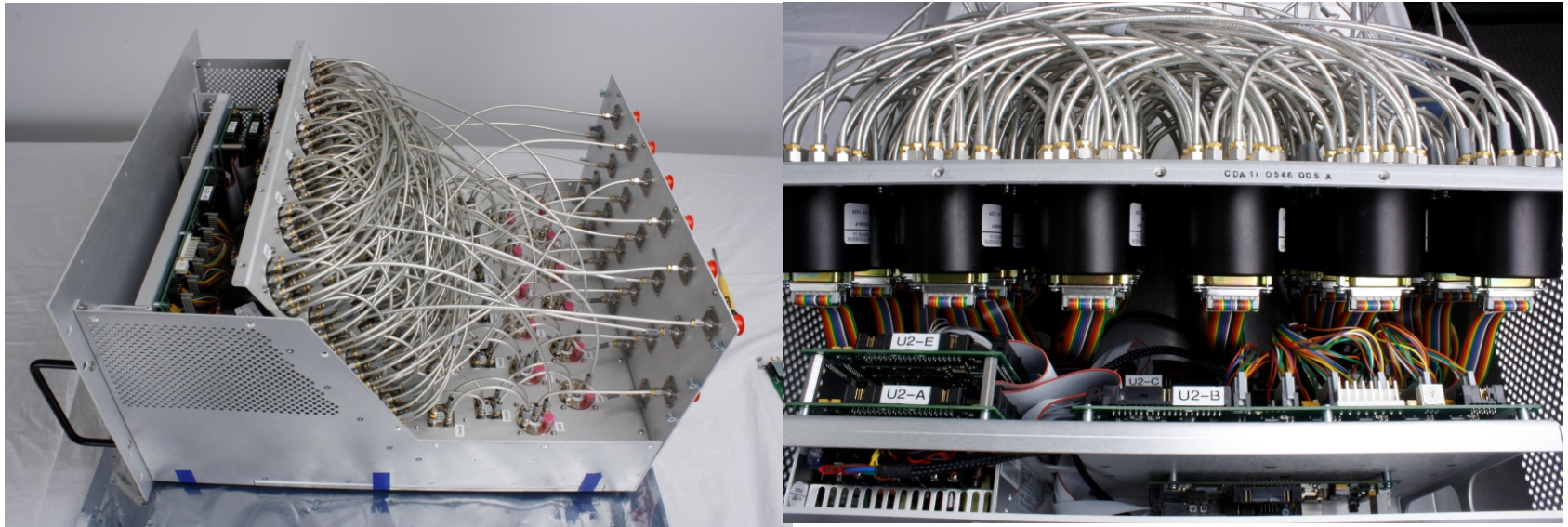
Qualcomm RF Matrix

Requirement:

- Programmable RF chassis two 2x16 matrix
- High performance evaluation Lab
- Aggressive IL and VSWR specifications
- 26.5 GHz system

Solution:

- EX7000 custom RF chassis
- Using a SP8T relays developed for VTI instruments by Radiall

Proposal:

- Delivered a full proposal with a 3D model
- Provided expected performance data
- Proposal and presented solution to customer in 5 day

Competition;

- ScenarioTech
- NI – using a PXI RF switching

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Qualcomm RF Matrix

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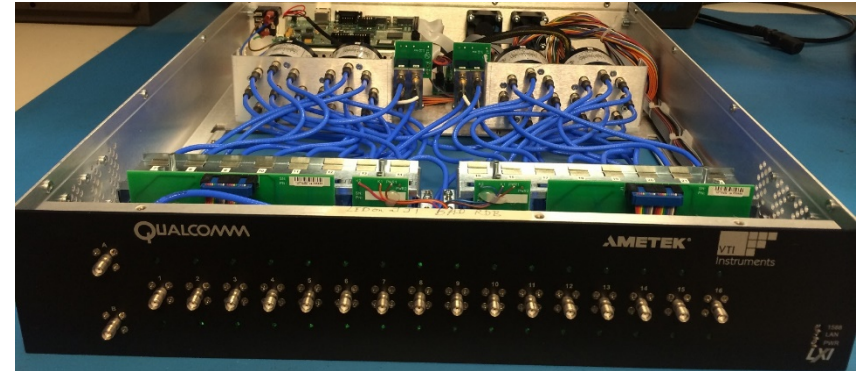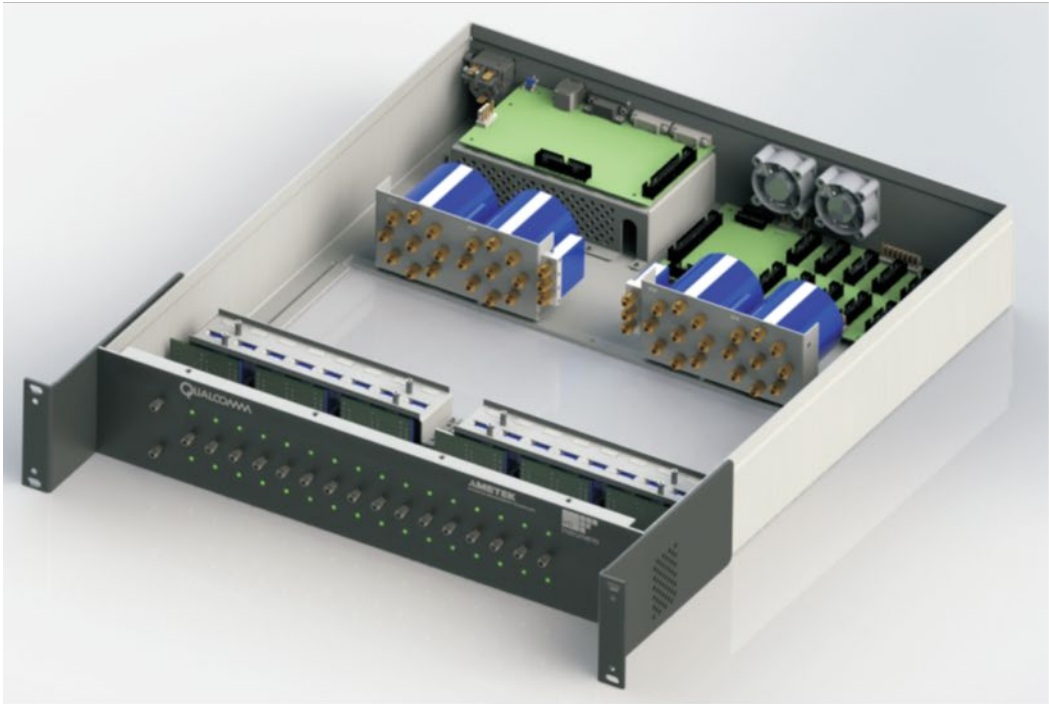
Qualcomm RF matrix switch

Solution: EX7000 Custom RF chassis

First order for 54 chassis 1.1 Million No NRE

Status:
Delivered over 154 chassis
Delivered 20 chassis to Qualcomm India
Delivered 36 chassis to Qualcomm Singapore
Placed an order for the Automotive evaluation lab
Additional future requirement for Automotive lab is 50 chassis

Who uses this technology:
Customers designing Cellular chip set 4G and 5G

- Intel
- Any Cellular, 4G & 5G chipset manufacturer

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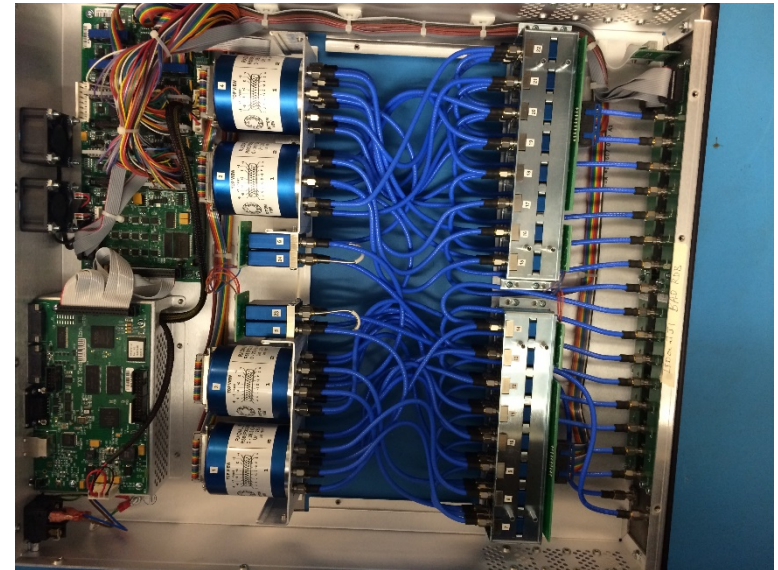
Google RF Matrix , case study

Requirement:

- Programmable RF matrix (4X4) with an integrated prog. attenuator (1-95dB)
- Testing Access Points routing to Client nodes
- Software interface using Python (Linux environment)
- 6 Ghz system

Competition:

- No competition, provide a technical solution at a target price

Solution:

- EX7000 custom RF chassis, proposal within 5 days including
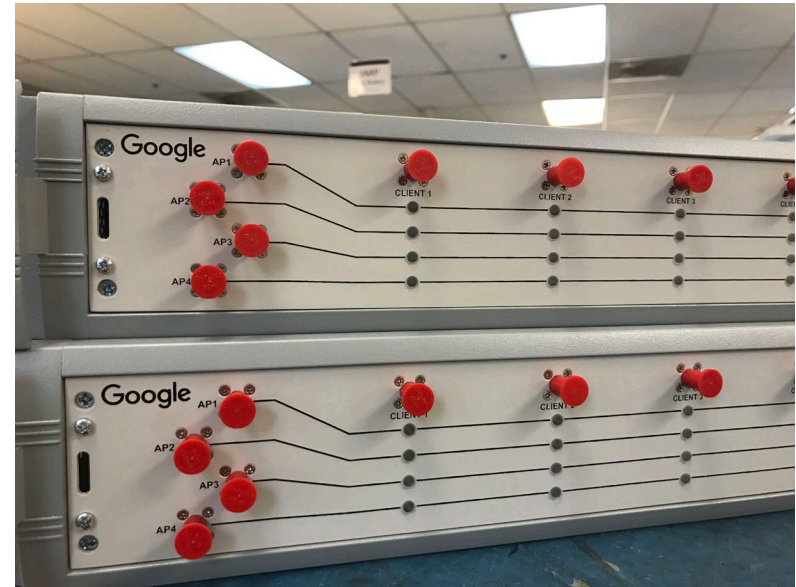 - Chassis 3D mechanical DWG
  - Expected performance (IL and VSWR)
  - Pricing data
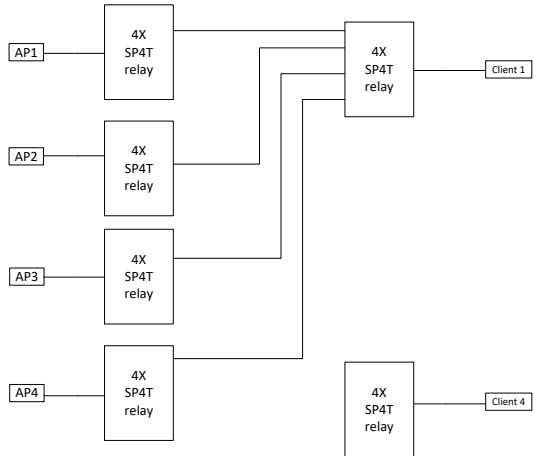
Google Case Study

- Commercial
    - Google matrix
        - 4x4 1- lane matrix
        - Future 4x4 4-lane matrix
        - 8 chassis delivered
        - Potential 50 chassis
        - 15K- 35K per unit

    Reasons we won
    1. Engage
    2. Understand
    3. Deliver

BAE

- Mill- Aerospace

  - BAE
    - IRIS - 9 different configuration 50K- 85K per chassis
    - Complete ITA - over 20 different configuration each with an IRIS 100K each
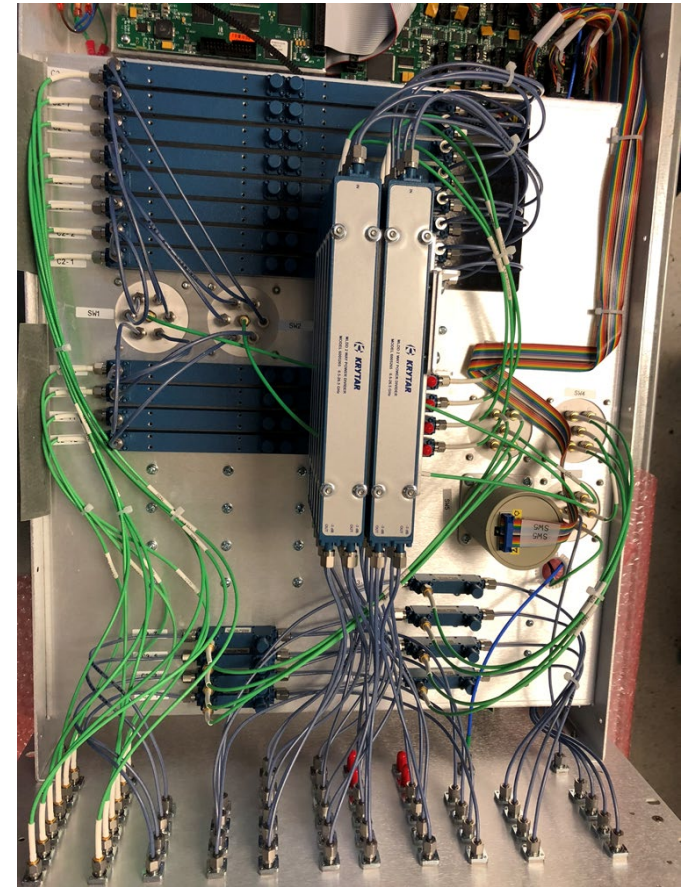
  Reasons we won
    1. Engage
    2. Understand
    3. Deliver

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BAE Emulator

- ## Mill- Aerospace

  - ### BAE Emulator
    - Simulate a large number of RF signals
    - Large number of components
    - Very challenging technical implementation
    - Very challenging time frame
    - Two chassis $200 K each

  Reasons we won
    1. Engage
    2. Understand
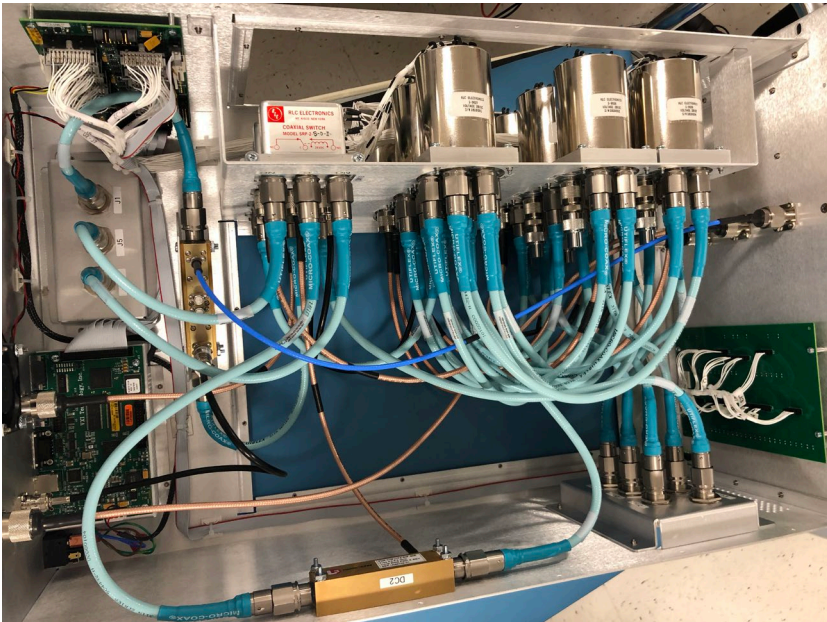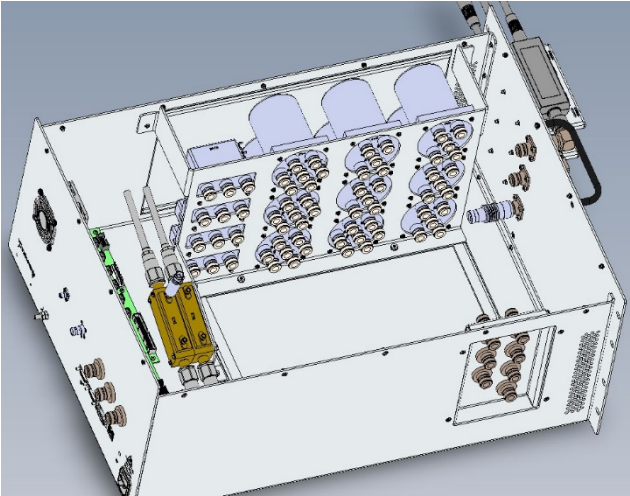   3. Deliver

Raytheon Case Study

- ## Mill- Aerospace

  - ### Raytheon high power switch
    - High Power (50K Watts)
    - Ran power through relay and cable, then opened both to review any damage
    - Special relays, Special cables and SC commenters

Reasons we won
1. Engage
2. Understand
3. Deliver

Access Panel Added for Easy Access to Relays

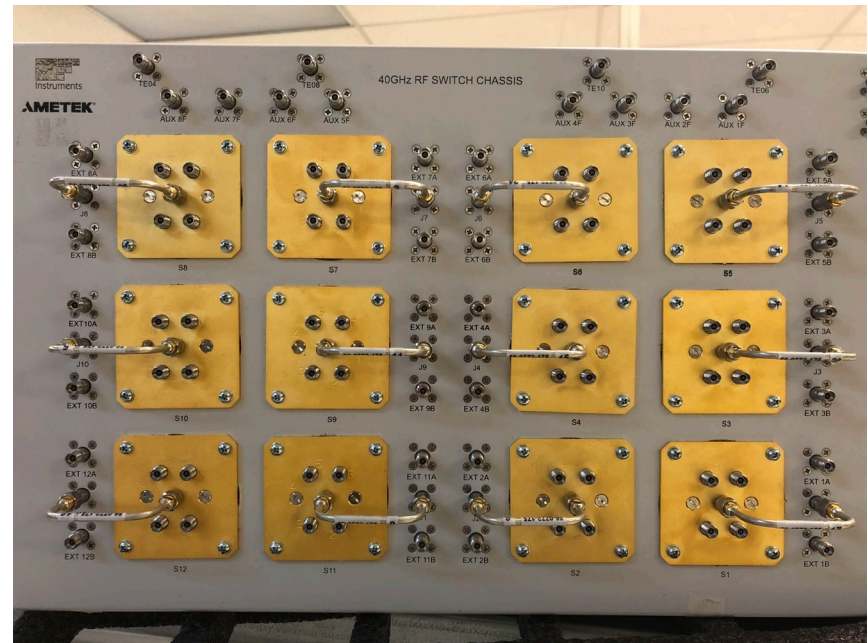RELIABLE DATA   FIRST TIME   EVERY TIME
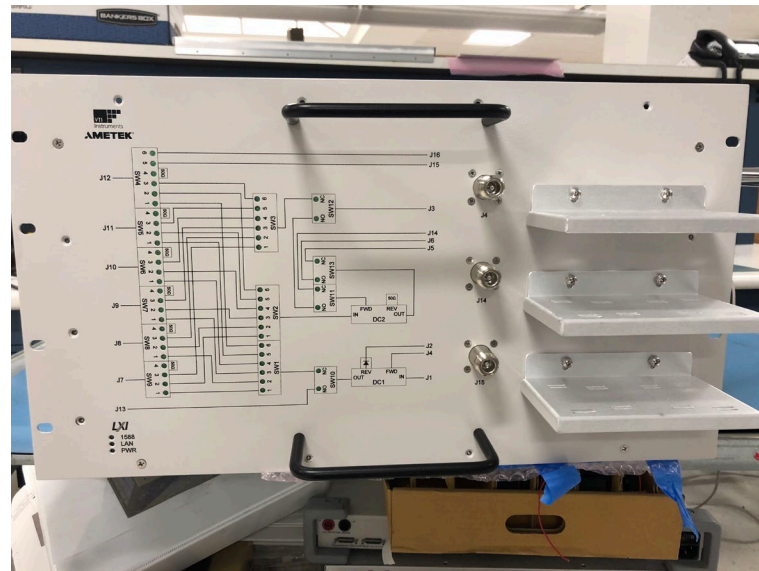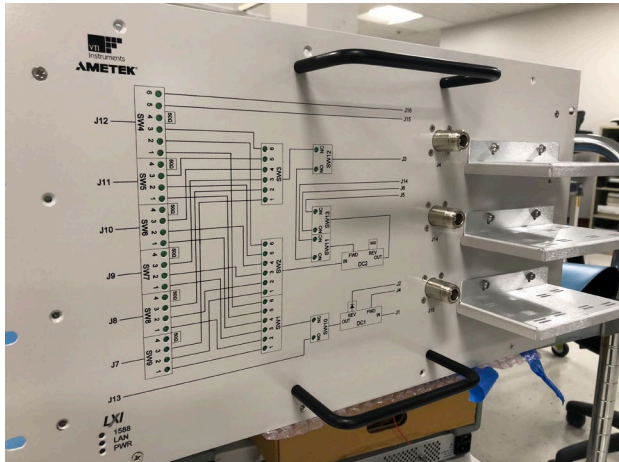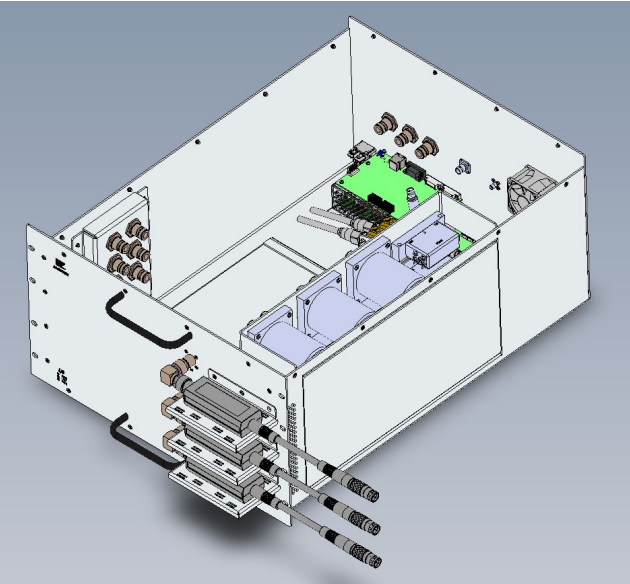
EX7000

- Mill- Aerospace

  - Largest chassis
    - Extended matrix (18X18 extended matrix with 744 paths)
    - 40 GHz Band
    - Competitive

Reasons we won
1. Engage
2. Understand
3. Deliver

RELIABLE DATA   FIRST TIME   EVERY TIME

Access Panel Added for Easy Access to Relays

RELIABLE DATA   FIRST TIME   EVERY TIME

EX7000

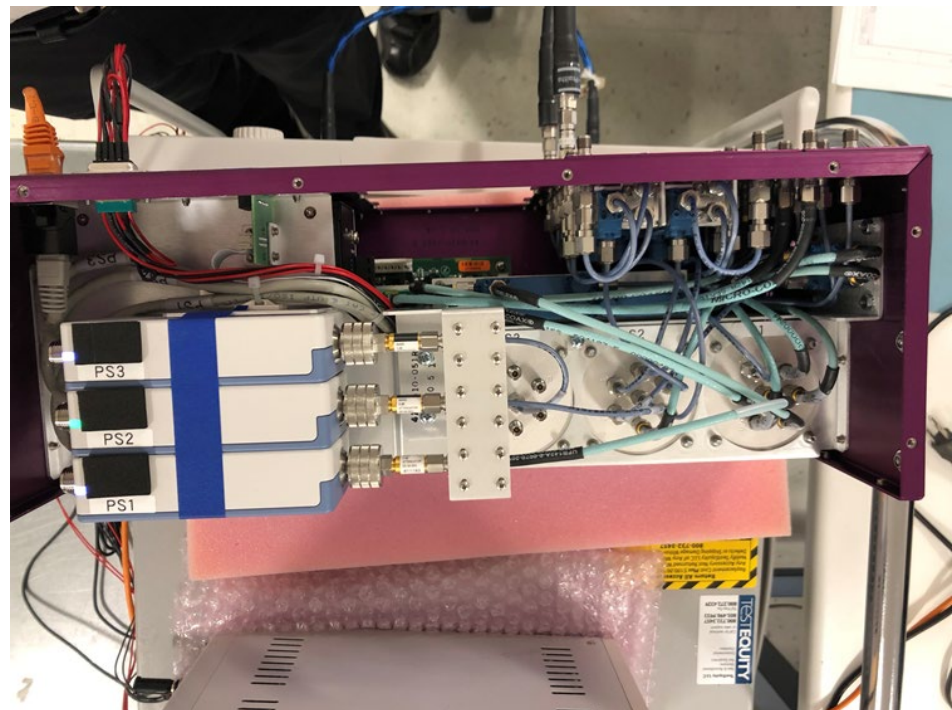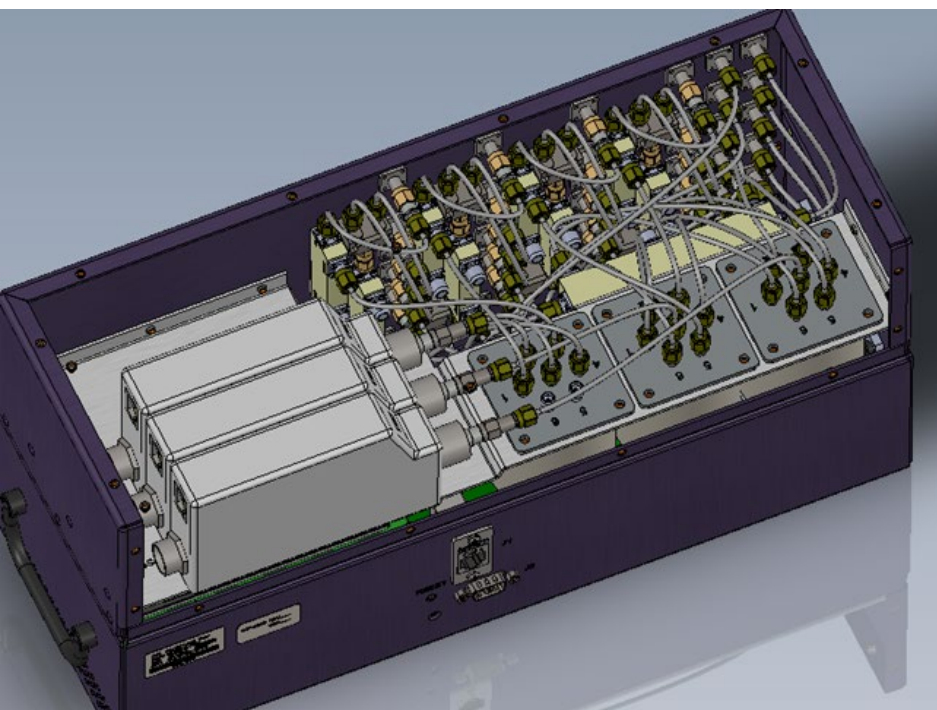- ## Mill- Aerospace

Most Technically challenging (electronically)
- Competitive
- 4X 6 matrix - 20 GHz
- SAT testing
- <u>Phase matched paths</u>

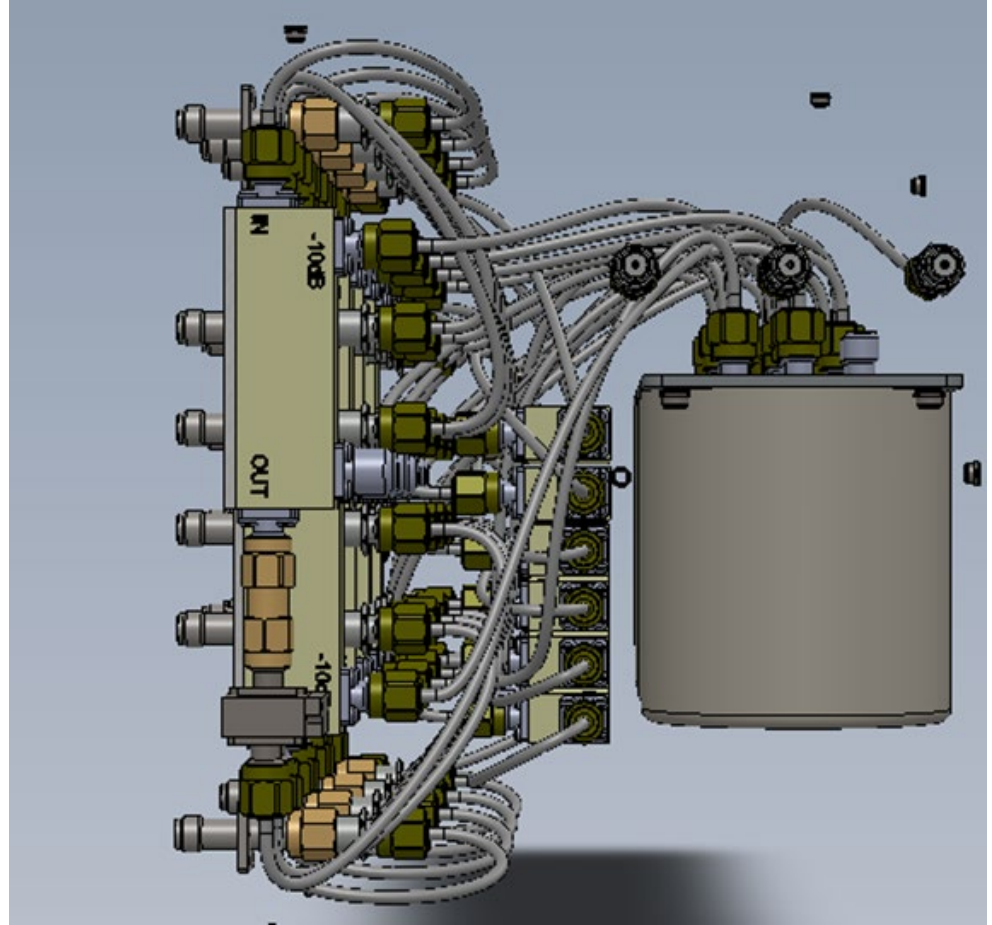Reasons we won
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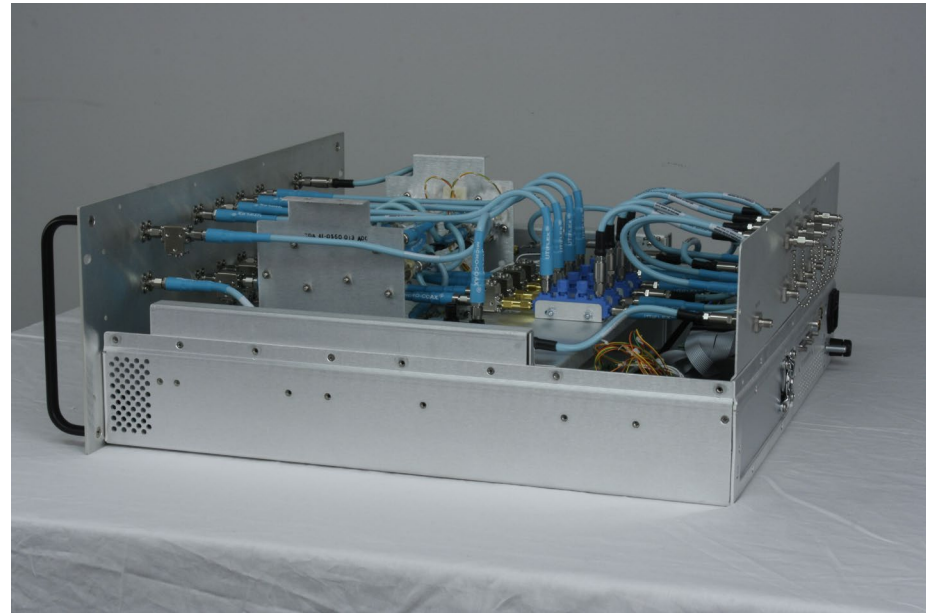
COMMON INFRASTRUCTURE FOR CUSTOM DESIGNS

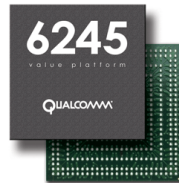RELIABLE DATA   FIRST TIME   EVERY TIME

RF and Microwave Solutions

APPLICATIONS

- Satellite
- Space
- Communications
- Mil/Aero
- Mobile radios
- Cellular
- Antenna systems
- Wireless peripherals, Bluetooth
- Broadband wireless transceivers
- RF Component Manufacturers

CUSTOMERS

- Qualcomm
- Raytheon
- Harris
- BAE Systems
- Broadcom
- Boeing Space System
- Lockheed Martin
- Magellan Aerospace
- Northrop Grumman
- Automotive (Bluetooth/Satellite)

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