

***Meeting today's
demands for
Validating, Verifying
and Certifying
complex SDR
Applications***



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- Changes in complexity that make this challenging.
- Harris experience in WF development and deployment.
- Verification, Validation and Certification techniques.
- Conclusions.

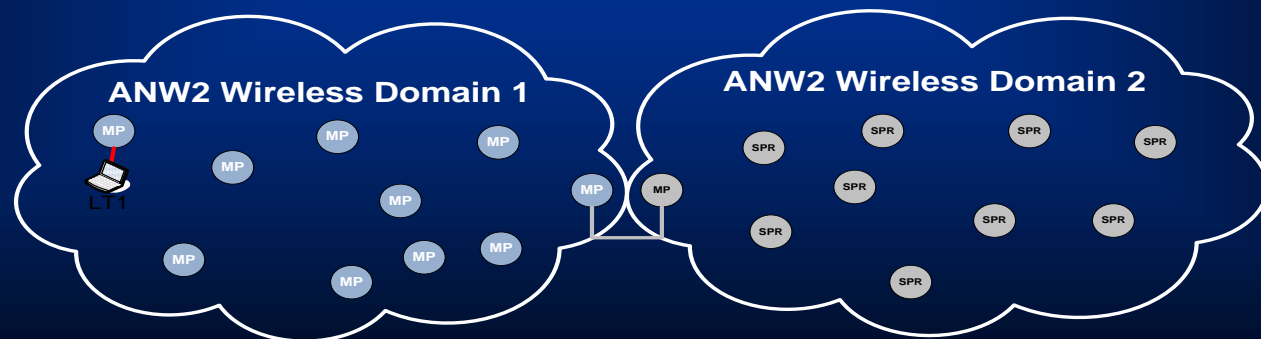




**Increasing
Waveform
and System
Complexity**

- Mobile Ad Hoc Network (MANET)
 - Scalable, dynamic network operating without a static infrastructure (i.e., cell towers, fiber optic cables)
 - Fast self-forming and self-healing network where nodes dynamically enter and leave and no defined topologies.
- Adaptation to varying RF channel conditions (i.e., interference, obstructions, node mobility)
 - Wideband channels with “signals-in-space” optimizations
 - Multiple modems, monitor link quality, automatically select appropriate modem
- Alphabet soup of routing protocols
 - OLSR, RIP, OSPF, PIM, NAT,...

- Large node counts
 - 30+ nodes in a network
 - Use of 'gateway' nodes to connect subnets operating at different frequencies
- Multicast capabilities: one sender/many receivers but not broadcast
 - Routing algorithm must be verified to assure delivery to only targeted recipients



- Multi-hop routing of voice and data
 - New routes must be verified as optimal as the topology changes
- Long distances (80km) require unique test approaches
- Quality of Service (QoS)
 - Multiple data streams with different QoS values makes it difficult to assure network is optimize
- Security
 - High assurance data security across combination of secure and non-secure networks.
 - Encrypted traffic transfer at multiple security levels.

- Next Generation of SATCOM WFs being deployed
 - DAMA is being replaced by Integrated Waveform (IW)
 - ‘Infinite’ combination of frame formats
- WF’s requiring more infrastructure
 - P25 Trunking requires Base Station
 - Channel controller and simulators for SATCOM WFs
 - MUOS cell based structure
- Proliferation of GUI-based applications without scriptable interfaces
- Increase in the number of app-layer systems (ADSI, AMANPADS, WDL, BFT, Fire Control)
 - Radio vendors do not have access to them



- Multiple system configurations as a result of different watt PA's, couplers and antenna types
- Requires B-LOS test capabilities
- Continual advances in HF capability
 - Fixed -> 2G -> 3G -> 3G+ -> WB
 - WB capability defined by 188-110C presents many options
 - 13 Waveforms
 - 8 Bandwidths
 - 4 Interleaver lengths
 - 2 FEC constraint lengths



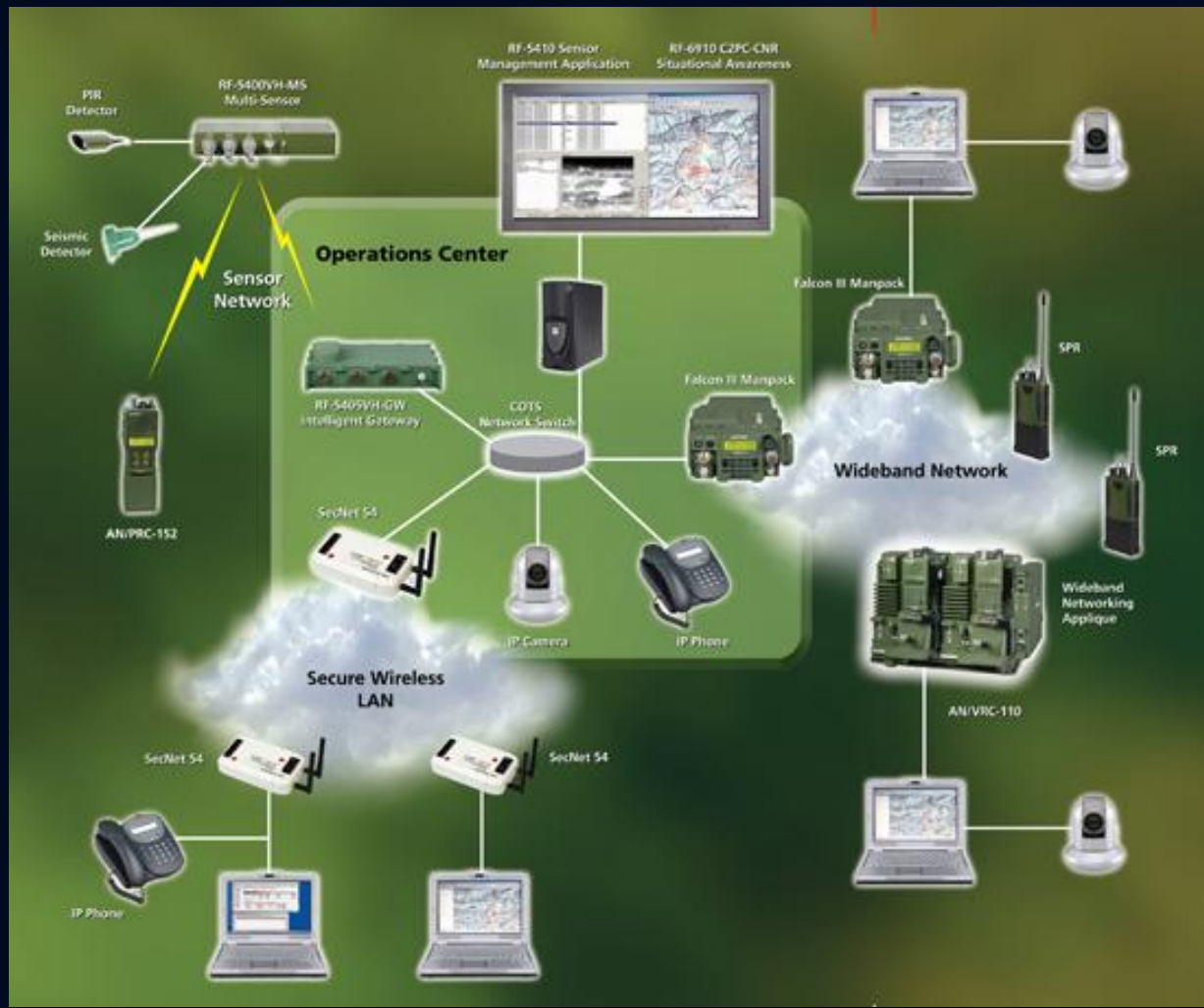
High Frequency WF Complexity



- MIL-STD-188-110C Bandwidth, modulation, bit rate options

Waveform number	Modulation	3 kHz	6 kHz	9 kHz	12 kHz	15 kHz	18 kHz	21 kHz	24 kHz
0	Walsh	75	150	300	300	300	600	300	600
1	2-PSK	150	300	600	600	600	1200	600	1200
2	2-PSK	300	600	1200	1200	1200	2400	1200	2400
3	2-PSK	600	1200	2400	2400	2400	4800	2400	4800
4	2-PSK	1200	2400	-	4800	4800	-	4800	9600
5	2-PSK	1600	3200	4800	6400	8000	9600	9600	12800
6	4-PSK	3200	6400	9600	12800	16000	19200	19200	25600
7	8-PSK	4800	9600	14400	19200	24000	28800	28800	38400
8	16-QAM	6400	12800	19200	25600	32000	38400	38400	51200
9	32-QAM	8000	16000	24000	32000	40000	48000	48000	64000
10	64-QAM	9600	19200	28800	38400	48000	57600	57600	76800
11	64-QAM	12000	24000	36000	48000	57600	72000	76800	96000
12	256-QAM	16000	32000	48000	64000	76800	90000	115200	120000
13	4-PSK	2400	-	-	-	-	-	-	-

Waveforms Developed and Deployed



Harris Experience

Harris WF Experience



- Extensive SCA based WF Development and Deployment Experience

Waveform	PRC-117G	PRC-152	PRC-152A	RF-310M	RF-7800M MP	RF-7800M HH
VULOS	X	X	X	X	X	X
QuickLook					X	X
HQ	X	X	X			
SINCGARS	X	X	X			
SATURN	Mar-2013					
TALON					Jan-2013	
HPW (IP)	X	X	X			
DAMA	X	X				
IW	X	X	X			
P25	X	X	X	X		
ROVER	X				X	
ANW2	X		X		X	X
SRW	X		X			

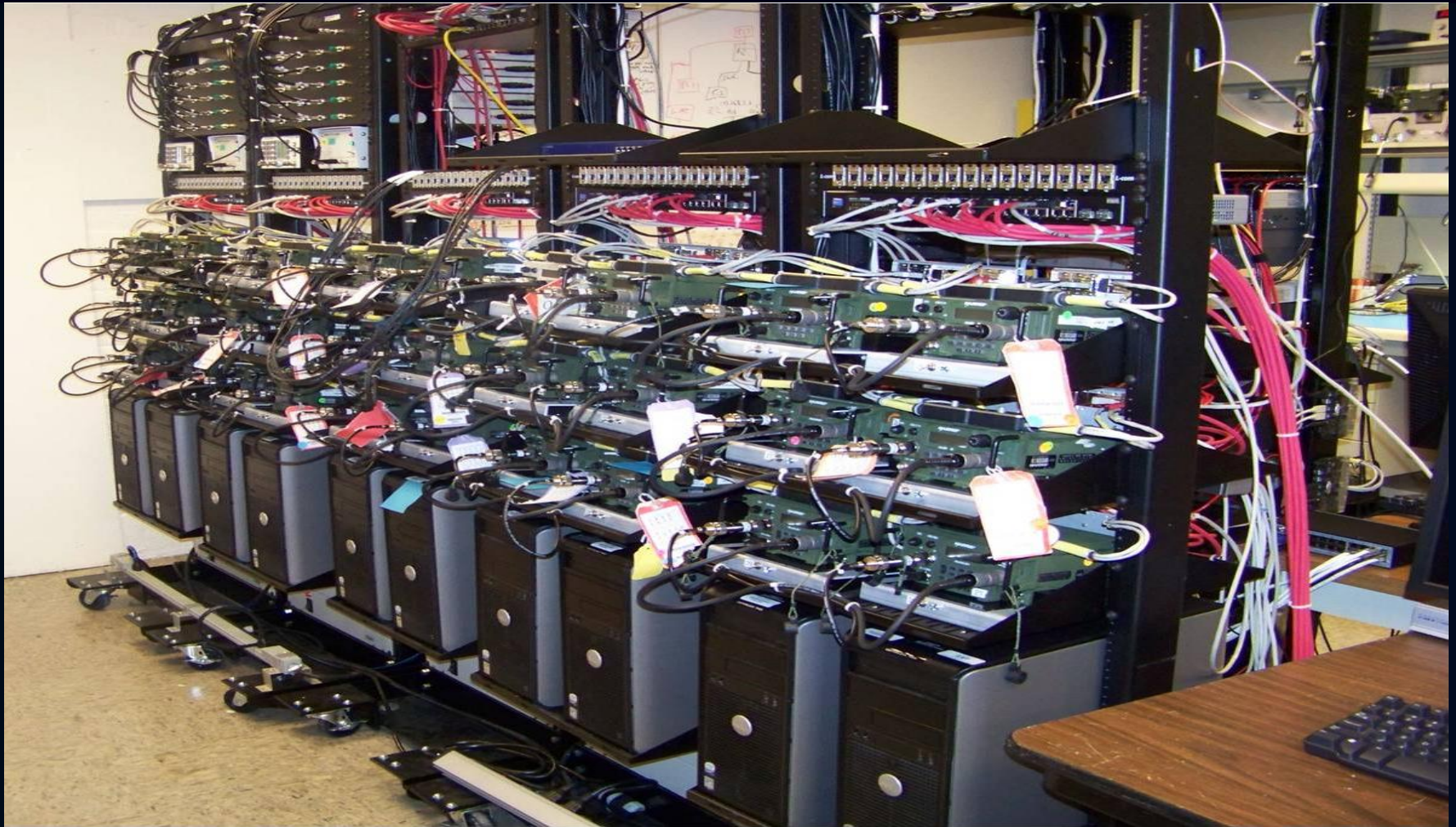
- Significant development of automated test procedures
 - Continuous performance testing: Nightly build tests
 - Test frameworks to drive GUI-based applications
 - Reduces user errors and drives to repeatable results
 - Increases the number of tests that can be executed
- Test Result Tracking
 - Automated Scorecard to track system performance

	STPs (high 6.0)		Regression (%)		Reliability (%)		Periodic (%)		Field Test (high 6.0)	
	<i>this month</i>	<i>last month</i>	<i>this month</i>	<i>last month</i>	<i>this month</i>	<i>last month</i>	<i>this month</i>	<i>last month</i>	<i>this month</i>	<i>last month</i>
Overall Radio Score	5.22	2.16	91.53	43.32	41.67	0.00	70.00	9.41	4.57	4.57
Platform Score	5.95	4.70	82.35	70.59	71.43	0.00	42.86	0.00	N/A	N/A
Non-Waveform Specific Score	5.48	2.89	100.00	100.00	100.00	0.00	N/A	N/A	N/A	N/A
FIX Score	5.60	2.71	97.62	92.86	75.00	0.00	63.64	0.00	4.71	4.71
2G ALE Score	5.90	3.12	89.55	86.57	35.71	0.00	68.75	0.00	5.00	5.00
HOP Score	4.98	1.37	97.22	69.44	50.00	0.00	N/A	N/A	5.00	5.00
3G ALE Score	5.00	2.03	92.74	81.45	33.33	0.00	58.33	25.00	5.00	5.00
3G+ Score	5.33	1.61	85.92	75.95	14.29	0.00	N/A	N/A	5.00	5.00
Scenario Score	5.05	2.20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
External Accessories Score	4.94	0.96	N/A	N/A	N/A	N/A	N/A	N/A	3.00	3.00
GPS Module Score	6.00	4.68	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Performance Score	N/A	N/A	N/A	N/A	N/A	N/A	87.50	8.33	N/A	N/A
Baseline Features Score	5.22	2.16	91.53	81.28	41.67	0.00	70.00	9.41	4.57	4.57
R1.2.0 Functional Score	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

- Network Simulator (NETSIM)
 - Support voice and data communications
 - Use of attenuation to simulate varying channel conditions
 - From perfect comms to broken link
 - Currently can test up to 30 node networks
 - Challenges based on networking complexities
 - Multicast: must monitor network and traffic flow to ensure all intended recipients received data despite varying channel conditions
 - Net Formation: Need to verify proper net formation based on conditions and link qualities
 - Propagation delays can not be simulated

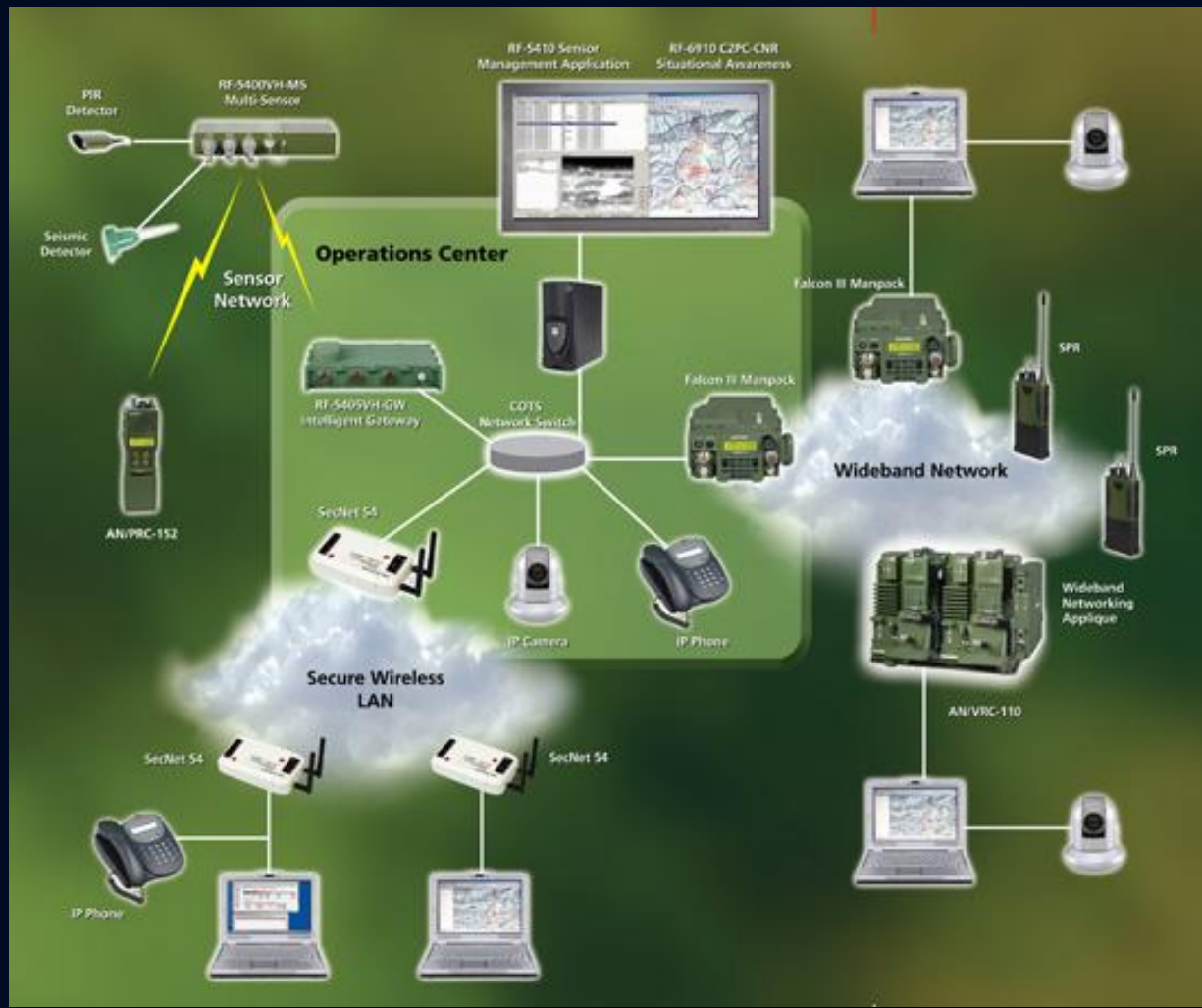
Test Infrastructure

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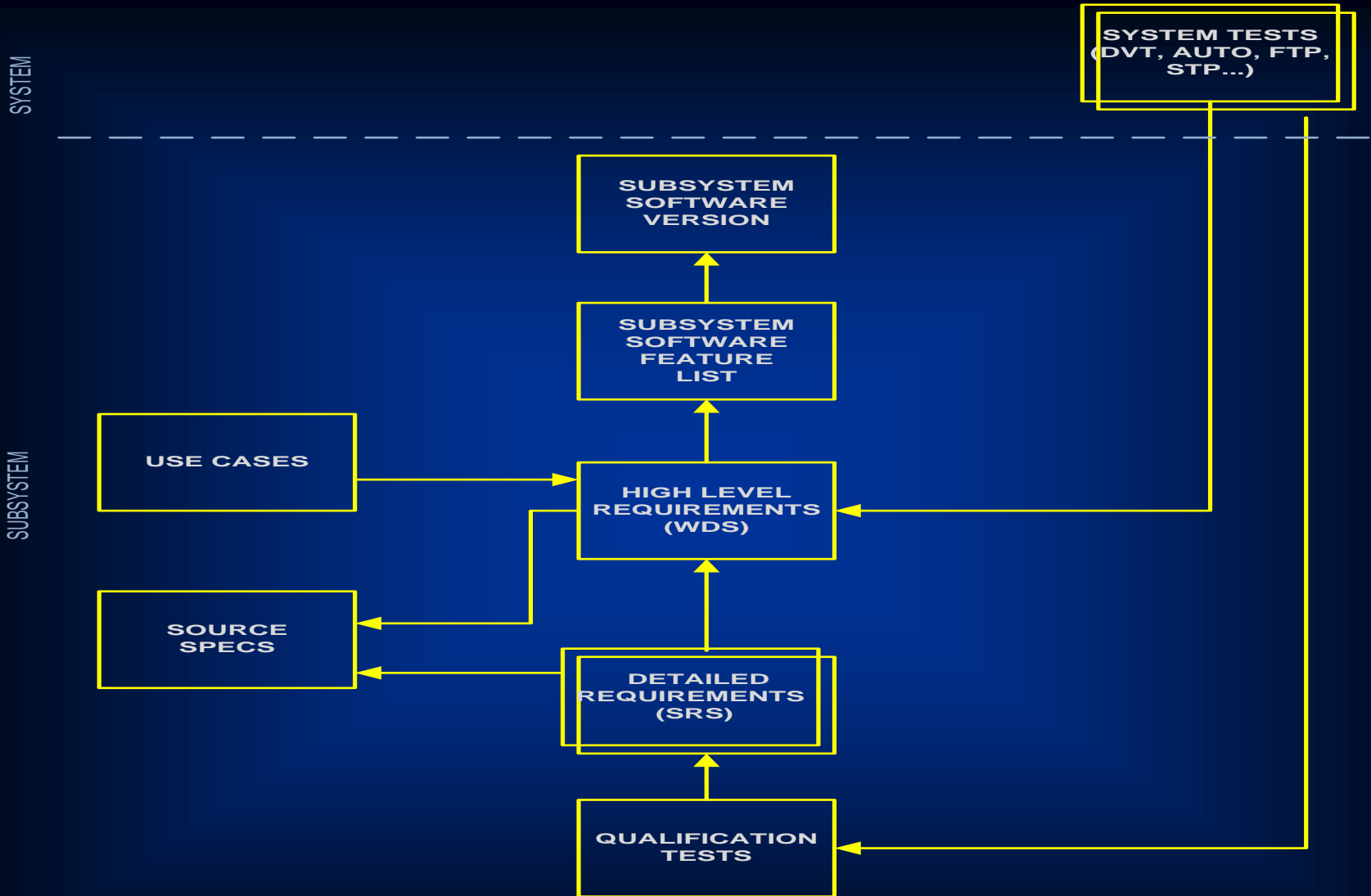
- HF Channel Simulator
 - Noise (fading, multipath, Gaussian) mixed via sound card in a PC and returned as RF
- SATCOM performance test stations
 - Engineering developed DAMA and IW Controllers allow for increased script controller
- Field Test capabilities
 - 11 test vehicles
 - Remote locations for BLOS comms
 - A roof top full of antennas





Harris Experience

Verification & Validation



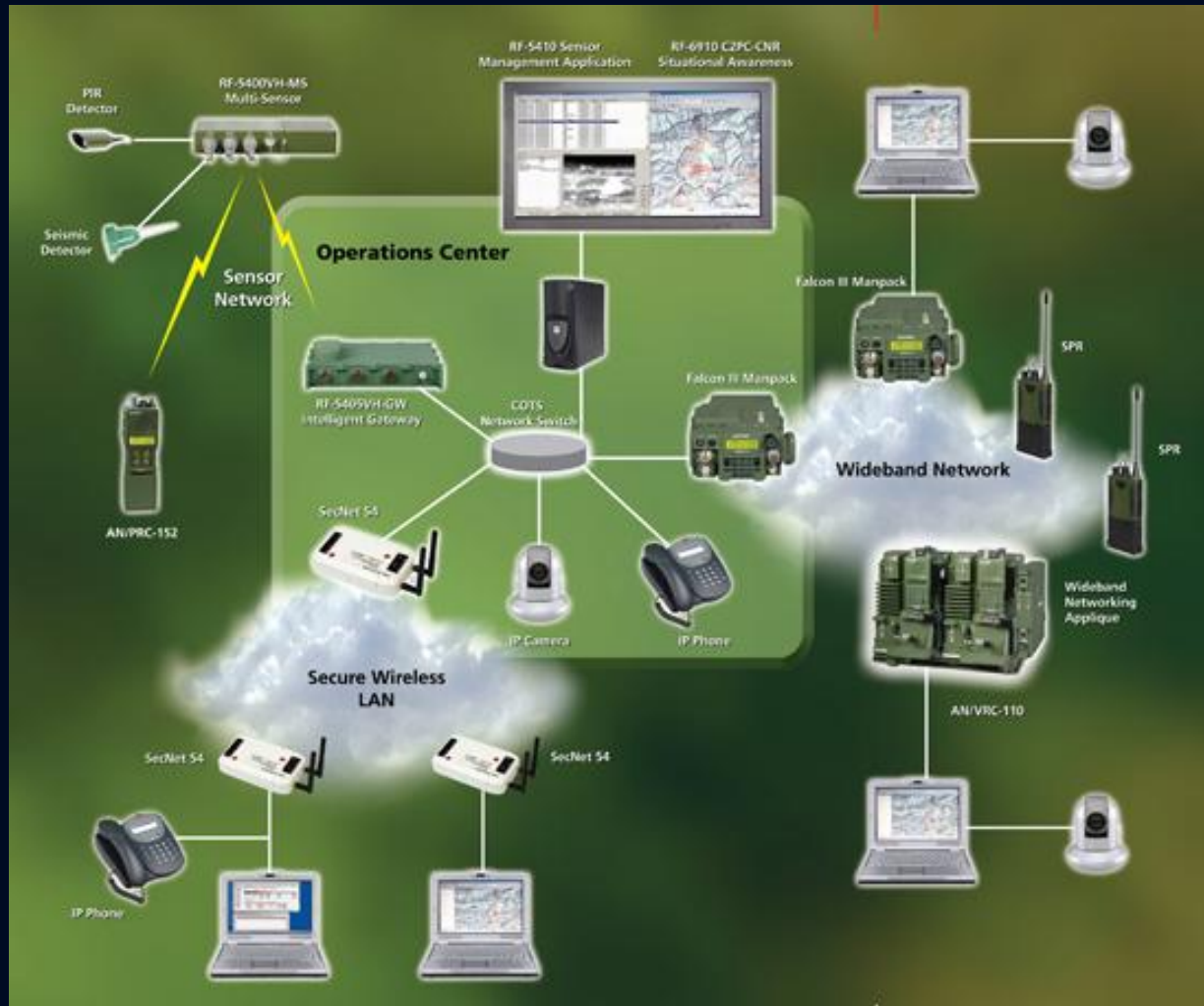
- Verification of the quality of the product...it does what it was defined to do
 - Code Analysis via peer review code Inspections and use of static analysis tools
 - Unit & Integration Testing
 - Qualification Testing to verify requirements
 - Tracing of Test Procedures to Requirements
 - Regression Testing
 - Ensure no negative side effects were introduced during the development cycle
 - Verify external interfaces have not changed to ensure integration to application has not been impacted
 - Reliability Testing to ensure the product meets quality and robustness Performance Parameters

- Test Result Tracking
 - Automated Scorecard to track system performance
- Recurring nature of QTs drove heavy use of automation to minimize the human effort required
 - Network Simulator for Networking Waveforms
 - Programmable Satellite Channel Controller for DAMA and IW
 - Integrated WF Performance Testing
 - Automated test setups
 - Significant Regression and Reliability testing

- The application does what the user expects
- Starts at the beginning of the project
- Validate CONOPs and Use Cases with the customer or voice of the customer
- Understand time-to-market characteristics of the development items
 - Incremental development approach
 - Initial focus on key CONOPS; frequent user feedback.
 - Start with basic functionality (i.e. node counts, ranges, net formation, modem performance).
 - Evolved domain knowledge along with waveform maturity.

- Feature and Key Performance Parameter validation via Scenario Testing
 - Based on System Level Requirements and Use Cases
- System Level Regression and Reliability Testing
 - High degree of automation leveraged
- Interoperability Testing
 - Conducted in house and at government test facility
- Field Test
 - Perform On Air testing as early in development as practical
 - Exposes different sets of problems than can see in the lab
 - Network Propagation Delays
 - Satellite Access
 - Atmospheric conditions
 - Replicate the user environment as much as possible
 - Land, Air, Water
- Environmental Testing

Certification Approaches



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- Standards based waveform can require performance certification prior to deployment.
 - MIL-STDs, STANAG
- Preparation is critical
 - Duplicate the test environment
 - Same Test Procedure and Expected Results
 - Test equipment and Gold Standard Radio
 - Execute dry runs until get the same results
 - Utilize the dry run radios for the certification
- Develop a relationship with the Certification Test lab
 - Maintain contact with Test Lab during the certification
 - Get periodic (weekly) results
 - Provide updates during the test cycle to address failures

- Most Certification Test Labs charge a fee to perform the testing
- Certification Test Labs often have multiple vendors
 - Can create a bottleneck and delay the release of products
- Performing the certification often results in delivery vendor Intellectual Property to the Test Lab

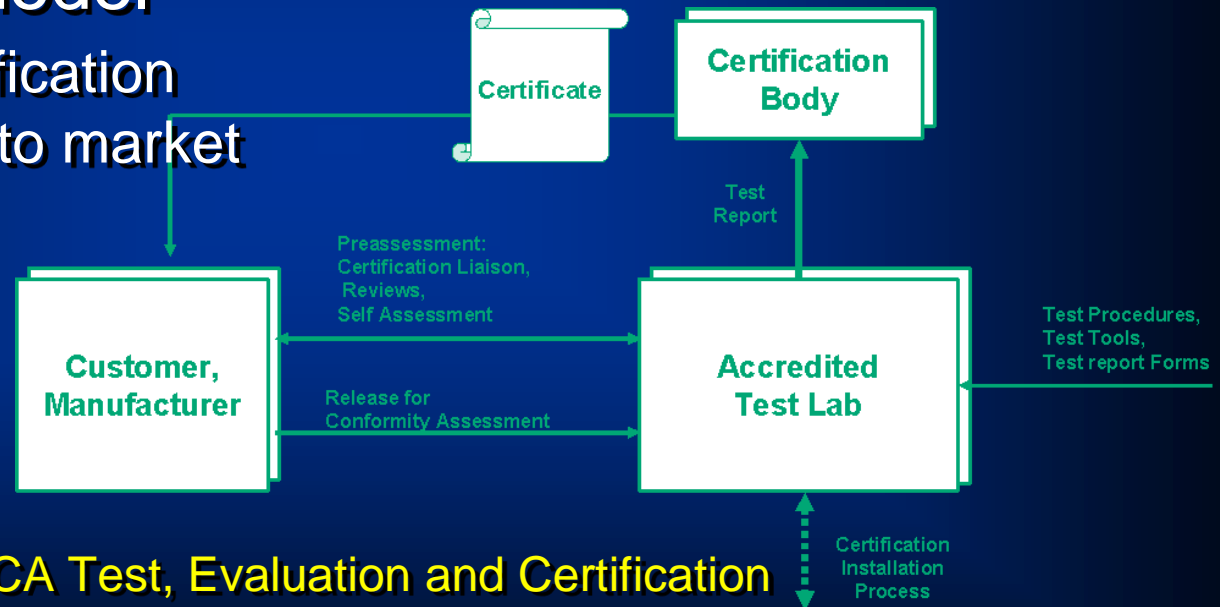


SCA T&E Working Group

- Development of a process to certify SCA compliance, targeted at procurement authorities, radio providers, other stakeholders.
- Defined a generic role based SCA test, evaluation and certification process in SDR-09-0007-V0.08 “Test and Certification Guide for SDRs Based on the SCA”.
 - Includes both a certification preparation phase and a certification execution phase.
 - Application to different operating models.
 - Supports accredited laboratory approach facilitating T&E capacity needs.

- Model that provides for self evaluation utilizing accredited test labs and tool suites and certification of results
- Addresses the issues inherent in the current certification model

- Minimizes certification costs and time to market delays
- Protects IP



SCA Test, Evaluation and Certification model defined by WINNF



Key Lessons Learned

- MANET waveforms present serious challenges
 - Test and verification of wideband networking waveforms requires significant scale, including applications validation.
 - Significant infrastructure required to test and verify wideband networking waveforms
 - Bound use cases through categorization and profiles where possible, especially for disadvantaged platforms.

- Made more difficult by support systems required by WFs
 - Simulators, Controllers, Base Stations
 - External applications
 - data/video transfer
 - position/location
 - network management

- Investment required in test infrastructure pays dividends in the long run
 - Simulators, performance test stations, field test capability
 - Replication of Certification Test Lab environment
 - Automation for recurring QTs, regression and reliability testing and tracking of results
 - Special purpose test stations
 - Field test equipment to validate operation in user conditions

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