



# Lucent demonstrates how ScanWorks for the Agilent 3070 can save nearly \$1 million per year

## Success Story

*“We are extremely excited about this partnership and the integration of the ASSET InterTech ScanWorks software with the Agilent 3070 platform. This innovation is one of many reasons why Lucent continues to look at Agilent as the leader in the test industry.”*

**Don Brogan**  
Advanced Technology Manager  
Supply Chain Networks  
Lucent Technologies

### Abstract

Ever on the lookout for ways to reduce costs and improve operating efficiencies, Lucent Technologies initiated a study to evaluate an implementation of ScanWorks™ software on the Agilent 3070 Series 3 in-circuit test (ICT) platform. Lucent anticipated that the ScanWorks/3070 combination could lower overall test costs and reduce printed circuit board (PCB) test complexity by allowing Lucent test teams to reuse boundary-scan tests at in-circuit test. The study demonstrated that significant time and cost savings on the test floor were possible, especially with regard to in-circuit test development, fixture costs and fixture maintenance costs. Savings in these areas represented a total potential savings of nearly USD\$1 million per year for Lucent. This paper summarizes the key results from the evaluation.

### Situation

Boundary-scan tests are increasingly used in benchtop R&D and prototyping environments to get an early, accurate test on PCBs with complex designs or hard-to-reach circuitry. These boundary-scan tests are often re-created at in-circuit test (ICT) for the same boards, adding unnecessary time and cost to product deployment. Lucent saw an opportunity for significant savings by leveraging boundary-scan tests across the product deployment cycle. The integration of ASSET InterTech's ScanWorks software with the Agilent 3070 ICT platform provided an answer. ScanWorks for the Agilent 3070 eliminates redundant boundary-scan efforts, allowing manufacturers to write boundary-scan tests once and leverage the tests through every phase of the manufacturing process, not only at ICT but also in the production line repair loop, at functional and environmental test, even in field troubleshooting and repair.



**Agilent Technologies**

## Method

Engineers from Lucent's Supply Chain Networks Division and Agilent's Test Solution Center worked together to perform an evaluation of the ScanWorks/3070 solution. The objectives for the evaluation were:

1. Demonstrate how benchtop ScanWorks tests for an actual Lucent production board could be reused on the Agilent 3070.
2. Quantify and report on measurable results and cost savings that could be realized by implementing a ScanWorks/3070 strategy.

The evaluation was performed in two steps. First, a complete Agilent 3070 program and fixture were developed using 3070-based

InterconnectPlus boundary-scan tools. This became the baseline for comparison. Second, existing ScanWorks tests that had been previously created in the benchtop environment were imported into the 3070. Comparisons between the baseline and ScanWorks implementations were then tracked for key metrics including:

- Reduction of in-circuit test development time
- Lower fixture complexity and costs
- Improvements in test stability
- No disruption to current processes
- Lower in-system programming costs

Economic impacts were then derived from these metrics.

## Test Development Cut by 42%

The combination of ScanWorks and Agilent 3070 InterconnectPlus boundary-scan tools can be used to accelerate test development while still meeting coverage expectations. Lucent's evaluation demonstrated that boundary-scan test coverage of over 70% can be achieved at ICT in less than half a day by simply reusing existing ScanWorks tests. If time allows, complementing the existing ScanWorks tests with 3070 "nail" tests, such as connect tests and powered shorts, can further improve test coverage as well as diagnostics. The result of this combined strategy (figure 1) reduced ICT test development and debug time at Lucent by four days, or 42 percent. As a volume manufacturer, Lucent can expect 70 such projects each year, which translates to an annual labor savings of about USD\$280,000.

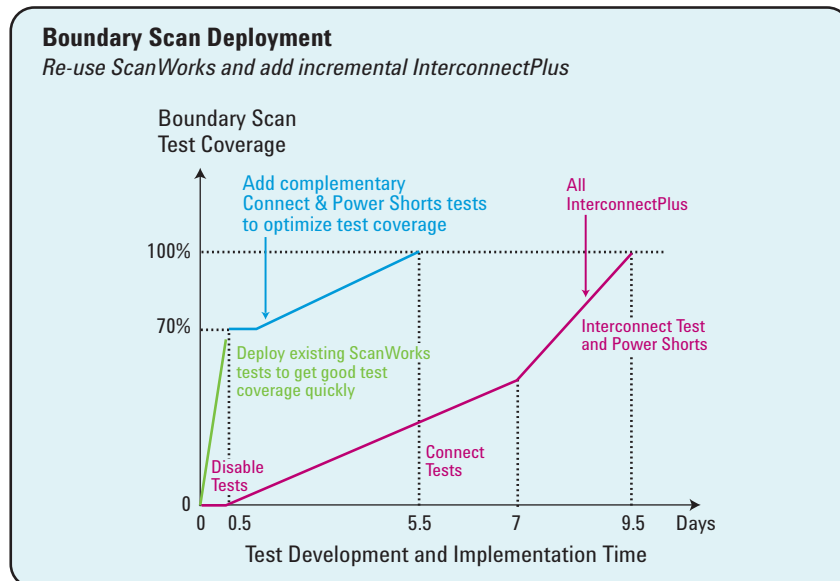


Fig. 1. Deploying ScanWorks at ICT to leverage an existing boundary-scan test produced 70% coverage with a half day of work. Adding complementary InterconnectPlus tools further increased coverage. In-circuit test development time was reduced by 42% for an ongoing annual savings of about \$280,000.

## Economic Benefit:

4 days  
x 8 hrs/day  
x \$125/hr  
x 70 projects/yr  
= **\$280,000 savings per year**

## Other Advantages:

- Boundary-scan development can be done before fixture fabrication, taking it out of the critical path for ICT.
- ScanWorks tests developed in design/prototyping are often created by engineers who are familiar with nuances of board design that allow design-for-test (DFT) to be incorporated more efficiently.
- ICT boundary-scan tests correspond exactly to those used in design/prototype.

*“The idea of code re-use really intrigued us here at Lucent and we were extremely satisfied with the results.”*

Michael Donlon  
Senior Test Engineer  
Lucent Technologies

### Lower ICT Fixture Cost and Complexity

Deploying boundary-scan with any in-circuit test will generally reduce the number of nails required in the ICT fixture since chained digital devices can typically be tested with a few test probes. However, as insurance in case the boundary-scan tests do not turn on at ICT, test engineers often add redundant test probes to the test and fixture. The ScanWorks/3070 solution eliminates this need by reusing known working boundary-scan tests. These tests can be deployed at ICT with a very high degree of confidence, so extra test probes are not required to maintain test coverage. The direct result is lower cost fixtures with fewer test probes and less wire mass, so they're easier and less expensive to build, debug and update. On the evaluation board used for this study, Lucent demonstrated that 2675 nodes out of a total of 5191 could be eliminated from the test fixture with minimal impact on test coverage. That represents a potential 52 percent reduction in node count, or a savings of almost \$700,000 annually.

#### Economic Benefits:

2675 nodes eliminated  
x \$4 per node (avg. of \$3-\$5/node)  
- \$800 per fixture (cost for ScanWorks extender)  
= subtotal \$9,900  
x 70 projects per year  
= **\$693,000 annual savings**

### Lower Fixture Maintenance Costs

Reducing the number of fixture probes means lower fixture maintenance costs and lower costs for probe replacement. With a better than 50 percent reduction in node count, Lucent estimates the savings at about \$21,000 per year.

#### Economic Benefits:

\$600 (current annual maintenance cost per fixture)  
x 70 fixtures  
x 50% (node reduction per fixture)  
= **\$21,000**

#### Other Advantages:

Fewer probes means reduced fixture complexity, which leads to the following benefits:

- Easier ECOs—less wire mass, easier to modify
- Lighter weight—fixtures are easier to handle, manage
- Easier maintenance—fewer probes to replace
- Higher reliability and repeatability—fewer probes allows for larger test pads, better probe contact and fewer false failures

*“I was surprised at the seamless integration of our ASSET ScanWorks program into the 3070 software. The process was quick and concise.”*

Michael Donlon  
Senior Test Engineer  
Lucent Technologies

### Stable, Reliable Tests in Production

With a ScanWorks/3070 strategy, boundary-scan tests have excellent stability at ICT in production test. That leads to fewer false failures and fewer good boards in the repair loop. It also means less debug and test maintenance in production—a key goal, especially for boards that are being transferred to remote production facilities.

### Eliminating Ground Bounce

ICT boundary-scan test failures and instability can often be traced to ground bounce. This phenomenon can occur when bed-of-nails fixtures are loaded with a large number of simultaneous switching nodes. This can create transient currents that are added up on the ground wiring between the device under test (DUT) and the test system, resulting in spurious noise on the boundary-scan signal lines (figure 2).

The ScanWorks/3070 implementation virtually eliminates ground bounce. Boundary-scan signals are generated by the ScanWorks PCI-400 card (residing in the 3070 controller PC). Signals are delivered to the DUT via Performance Port, completely bypassing the 3070 pin electronics. With this implementation there is little loading between the DUT and the PCI-400, and ground voltage transients are minimized (figure 3). Test instability due to ground bounce was virtually eliminated. The Lucent board was cycled over 50 times at ICT with no test instability.

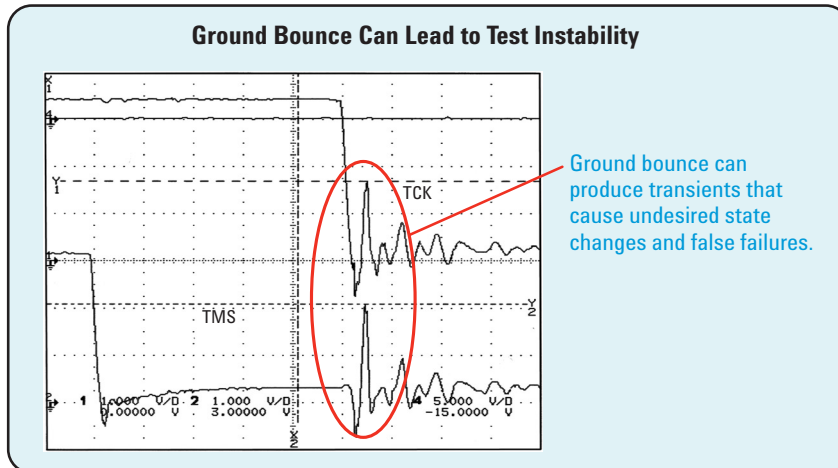


Fig. 2. The ScanWorks/3070 solution makes a difference. Ground bounce can produce transients that cause undesired state changes and false failures, so good boards end up in the repair loop.

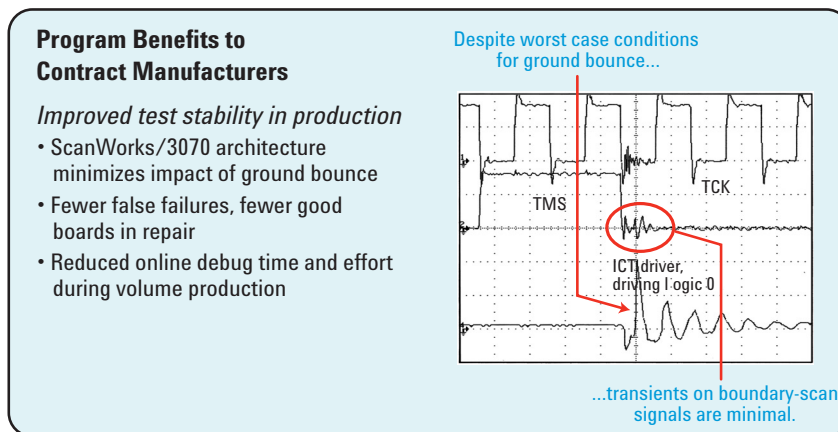


Fig. 3. Despite worst case conditions for ground bounce, transients on boundary-scan signals are minimal thanks to the ScanWorks/3070 solution.

### Program Benefits to Contract Manufacturers

#### Improved test stability in production

- ScanWorks/3070 architecture minimizes impact of ground bounce
- Fewer false failures, fewer good boards in repair
- Reduced online debug time and effort during volume production

### No Disruption to Current Processes

Agilent Technologies and ASSET InterTech collaborated to integrate the ScanWorks solution on the 3070 ICT platform. The result is a seamless integration that minimizes the impact to production when deploying a ScanWorks/3070 test strategy. Lucent studied the following attributes as part of its evaluation of ScanWorks/3070:

- Integrated, single repair ticketing
- Unchanged operator user interface: no additional/special training or actions required on the shop floor
- Integration of ScanWorks with 3070 coverage reporting: ScanWorks included in 3070 Coverage Analyst tool
- Automatic translation of part designators (if different between 3070 and existing ScanWorks tests) so 3070 repair ticket is consistent
- Accurate pin level diagnostics: reduces time and cost in repair
- High volume manufacturing capabilities, including board handling

Bottom line: tight integration between ScanWorks and the 3070 ensures an easy transition of board tests to volume production, which is increasingly important as Lucent distributes its manufacturing operation worldwide to minimize costs and improve margins.

### Lower In-System Programming Costs

The Lucent board included an FPGA Configuration EPROM. The program for this device was imported to the 3070 in minutes as part of the ScanWorks project, and executed in a half second at runtime. This compares to a four-hour test development effort and a three to five second runtime using the existing “svf-to-pcf” translation technique on the 3070.

Programming PLD and flash devices at ICT can lower production costs further by eliminating an extra programming step, reducing device handling and inventory, and eliminating the costs of doing ECOs on preprogrammed parts.

### Summary of Key Results

Lucent demonstrated significant cost and time savings without loss of test coverage when using the ScanWorks/3070 solution. Key results include:

- 42% reduction in test development time by reusing boundary-scan tests (reduced from 9.5 days to 5.5 days)
- Over 70% boundary-scan defect coverage with ScanWorks only, with minimal (half day) development effort
- InterconnectPlus tests (connect test, powered shorts) add incremental test coverage and diagnostics with additional test development time
- Total nodes saved: 2675 out of 5191, a savings of about \$10,000 per fixture
- Excellent test stability, repeatability in production
- Fast, convenient FPGA programming available via ScanWorks

### Summary: Economic Benefits

Certain metrics were tracked during the Lucent evaluation for the purposes of calculating actual, measurable cost savings that could be expected for similar board types. These economic benefits include:

- Annual Test Development Savings = \$280,000
- Annual Fixture Development Savings = \$693,000
- Annual Fixture Maintenance Savings = \$21,000
- Total Annual Savings: USD\$994,000

### Conclusions

Lucent demonstrated that reusing ScanWorks boundary-scan tests on the 3070 ICT platform can produce dramatic cost savings. OEMs can see lower test development costs and time savings as well as reduced fixture cost/complexity without giving up test coverage. CEMs get stable, repeatable tests that need little maintenance during production; can deploy ScanWorks/3070 tests with virtually no changes to existing 3070 test processes; and can see lower fixture maintenance costs since fixtures are less complex. Additional savings can be realized by reusing the ScanWorks boundary-scan tests in other stages of the product lifecycle such as functional test, environmental test, and field repair.

### The Board

Board Size: 14" x 15"

Total node count: 5191

Number of nodes without probe access (including those removed using Access Consultant): 2996

Total pin count: 15,122

Number of boundary-scan chains: 1

Number of digital devices in the chain: 16

### Technology Highlights

1. High pin count FPGA (1,157 pins)
2. Multiple logic families (1.5V, 2.5V, 3.3V, 5.0V) on the same device and in boundary-scan chain
3. Low Voltage Logic (1.5V Logic)

### Device Types

1. 44 Digital IC's including Xilinx Virtex-II FPGA's (XC2V3000, XC2V6000), 1Mbit ISP Configuration PROM (XC18V01), Lattice ISP CPLD (ISPLSI2032), Micron Quad Data Rate SRAM (MT54V512H18), 4K I2C Serial EEPROM, PLL's and high speed clocks.
2. 1150 resistors, 32 resistor packs, 634 capacitors, 7 inductors, 12 diodes, 6 Zener diodes, 1 transistor, 4 FETs, 9 connectors.
3. 3 DC-DC Converters, 2 DC-DC Inverters, 2 Regulators, 2 Dual Opto Couplers, Power monitors, OpAmps, Comparators.

### The Tester

Lucent's evaluation was conducted on the most recent Agilent 3070 hardware and software release. State-of-the-art 3070 hardware and software created certain advantages:

#### Industrial PC Controller for the 3070

- Superior performance: test compile times 3-5 times faster than UNIX®, runtime execution also faster
- Ease of administration: lower administration costs, easier to hire Microsoft Windows®-trained administrators
- Lower entry cost compared to UNIX

### 3070 Software Release 05.21

- Interoperability between UNIX and PC platforms for seamless transition of programs between systems
- Upgrade directly from revision 3.8x to 05.21; reduce time to access new release benefits

#### Other 3070 features available with release 05.21

- No-Wire Fixturing Technology
- Localizable operator interface
- "Re-test Until Pass" to provide flexibility on the production floor
- Enhancements to Coverage Analyst
- Test stability enhancements for InterconnectPlus
- Over 90 enhancements related to defect fixes and customer requests

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