



Changing the Game in **Material Movement**



A new approach to material handling for non-automated 200mm and 300mm fabs combines real-time wafer lot location and workflow technologies to improve productivity without disrupting ongoing manufacturing. This material management solution can significantly reduce costs and repay the initial investment in its first year of operation.

Many established semiconductor fabs do not have an automated material handling system (AMHS) that provides tool-to-tool material delivery. In these fabs, operators manually load and unload tools, initiate tool processing, and log process results. Operators also select the next lot to process, physically locate the lot, transport the lot through the factory, and store the lot until it is ready to be processed again on the next tool. Factory automation (FA) software assists operators, but many actions and decisions are still left to operator discretion.

Studies show that at least 20% of an operator's time is spent tracking and locating material and interacting with the factory manufacturing execution system (MES). Even with the MES, locating a lot in a storage location takes time. If a lot location is logged incorrectly or the lot is misplaced, finding it can be a time-intensive process.

REAL-TIME SOLUTION

A new system, Applied SmartMove, greatly reduces the time operators spend tracking and finding material by combining two existing technologies:

- A real-time location system (RTLS) that employs both radio frequency (RF) and ultrasonic tracking technol-

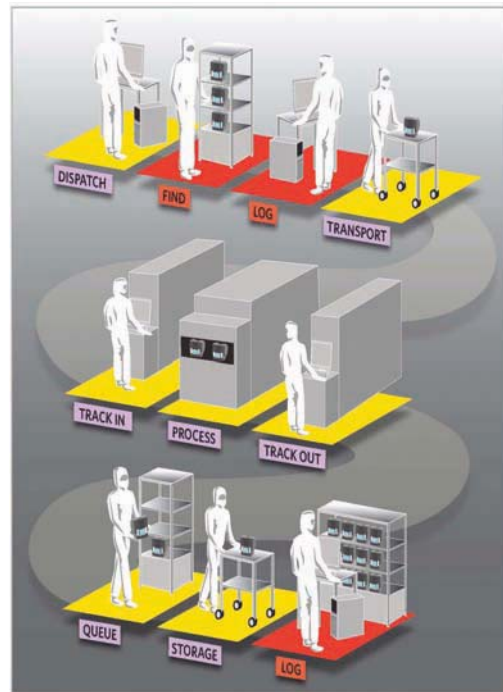
ogy and uses two-way interface devices (tags) to locate lots and communicate with operators.

- Workflow automation software that integrates the RTLS with the existing MES.

With SmartMove, when the MES selects the next lot to process on a tool, the FA system supplies the lot location and helps the operator identify the lot via a flashing indicator on the tag. The text display on the tag confirms the destination tool for the lot and provides useful information, such as the process recipe. Figure 1 depicts the steps an operator follows to process a lot on a tool and highlights the non-value added steps that can be eliminated by using an RTLS.

RTLS COMPONENTS

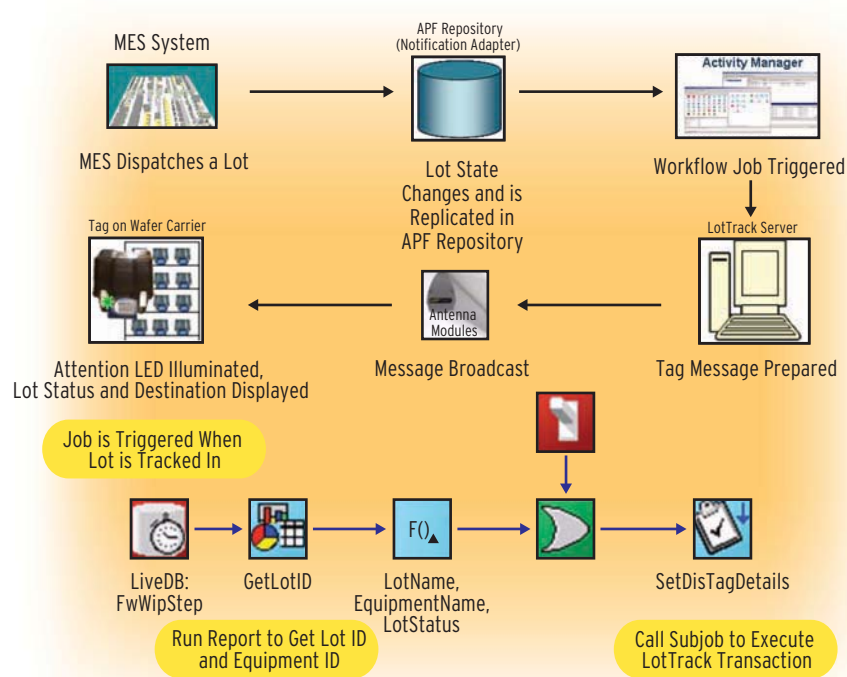
The RTLS technology, illustrated in Figure 2, is provided by Intellion AG. Active tags attached to wafer carriers communicate with a network of antennas placed in the ceiling of the fab. Messages exchanged between the tag and antenna enable the RTLS to determine the location of a tag/carrier pair, communicate with the tag to toggle an attention LED, and display operator messages. Installing the RTLS is straightforward and does not require production to be interrupted.



▲ **FIGURE 1:** The material handling steps marked in red can be eliminated or optimized with RTLS and workflow technologies.

- ▶ **FIGURE 2:** Using RTLS technology, active tags on wafer carriers communicate via an easily installed antenna network on the fab ceiling to determine lot location and display operator messages.





▲ **FIGURE 3:** Illustration of RTLS and workflow integration showing the sequence of steps between the MES, workflow technology and RTLS that result in a tag instructing an operator to move the lot to the selected tool. The lower portion of the illustration shows the dispatch logic in the workflow graphical interface.

INTEGRATION WITH EXISTING FA

To maximize efficiency gains, the RTLS must work together with the existing FA software. For example, when the MES requires a lot to be processed on a tool, the display message and attention LED for the tag need to be set to help the operator find and deliver the lot to the correct tool. Figure 3 illustrates a sample workflow defining a fab business process that will be executed by the workflow automation. When the lot is dispatched by the MES, a workflow is triggered that calls the RTLS software to set the tag display and turn on the attention LED. To speed the deployment of the RTLS, the new required business processes are delivered in the form of pre-built workflows.

Fab Deployment Requirement	Example	Solution
Define new business processes	Set attention LED and message on lot dispatch	Predefined workflow start up models
Link to factory automation	Update locations in MES as lots move	Workflow integration Applied deployment services
Rapid ROI	Deploy new system quickly	Startup models Applied deployment services
Risk to running or ramping fab	Can't impact current production	Business logic triggered by events in MES, no need to change MES code
Continuous improvement	Improve business processes over time	Workflows are easy to change and extend
Production volume and reliability	1,000s of tags, many transactions, 24x7 operation	Production proven scalability, reliability, and expertise

▲ **TABLE 1.** The Applied SmartMove solution provides a rapid low risk deployment.

CUSTOMER RESULTS

RTLS is a key element of a multi-year production improvement program at a large European manufacturer that generated reported savings of \$21M. A logic manufacturer implemented RTLS to improve fab performance and reported an 82% reduction in lot delivery time, a 13% improvement in on-time delivery, and a 7% improvement in labor productivity. A large memory manufacturer using RFID technology saved \$900k per year in operator time, simply by eliminating the need to log lot locations in the MES.

A large semiconductor foundry deployed Applied's workflow technology in their 200mm fabs. Baseline productivity studies showed operators were dealing with many factory exceptions that resulted in less output and longer cycle times. The customer deployed workflows to automate standard exception processing, resulting in an 18% fab throughput increase.

By combining RTLS and workflow technologies, the SmartMove system can be deployed rapidly and easily in an operating fab. Pre-built workflows reduce the risk, expense and time required for integration with the existing FA system. Also the workflow automation software includes the capability to detect activities in the existing FA system, such as the dispatching of a lot to a tool, and in response can

initiate a workflow, without requiring the risk of changes in the existing factory automation software. Table 1 charts the potential deployment risks and challenges and how Applied's workflow technology mitigates these concerns.

FURTHER OPTIMIZATION OPPORTUNITIES

Beyond raising operator productivity by optimizing material handling, the combination of RTLS and workflow technology offers additional capabilities:

- The ability to track other factory resources in addition to lots, such as photomasks and maintenance equipment.
- A new communication channel *to* operators. In addition to the attention LED and lot destination, other time-critical information is available regarding lots to operators, such as service instructions and broadcast messages, particularly with non-wafer lot tags.
- A new communication channel *from* operators. Tags can convey simple information back to the FA system via soft keys on the tag. These buttons can be used to provide quick feedback to the factory automation system, such as the process outcome or exception notification, freeing the operator of the need to log into an MES terminal.
- Workflow automation software provides the general capability to implement new factory business improvements with guidance from the factory automation system. This capability can also be used in conjunction with the RTLS capabilities listed above, but it can also be used to develop other factory productivity improvements.
- Location information can be used to optimize fab decisions—the choice of the next lot to process on a tool can include the current location information of the candidate lots, perhaps giving a higher priority to closer lots, reducing transit time.



Performance Driver	SmartMove Capability
Increase operator efficiency	2-5% less operator time for lot searching 1-3% less time to get info Less operator time for unnecessary transports
Increase throughput	Up to 10% throughput increase Easily followed dispatch list priorities
Decrease cycle time	5-15% cycle time reduction Improved adherence to dispatch rules Hot lot management Lots staged next to bay Lots transferred directly from one tool to the next
Meet delivery schedules	Improved dispatching Less cost for exception handling Late order flexibility
Improve quality	Less scrap (follow-up cost, timer lots) Less paper and particles in fab Less work due to misrouting and misprocessing Improved properties of time/moisture sensitive films due to reduced queue time
Decrease WIP	5-15% less WIP

▲ **TABLE 2.** Fab productivity challenges that can be met by SmartMove.

Table 2 lists some of the fab productivity challenges that can be addressed using SmartMove technology.

CONCLUSIONS

For fabs without AMHS, the combination of RTLS and workflow technologies can optimize material management in the fab and improve wafer output by up to 10%. Applied Materials has developed an integrated solution with these technologies that includes pre-built workflows, deployment services and post-deployment support. This material management solution offers a low risk, rapid deployment without disrupting ongoing production, and a typical ROI of less than 9 months. The technologies can also be used to improve a wide range of additional fab business processes. ■

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