



Equipment Supplier's Basic Operational Scenarios For Automation

AUX 0013-0705

Foreword

Publication of this document as Auxiliary Information independent of any standards was authorized by a 2/3-majority vote of the Japan Information and Control (I&C) Committee at its meeting in SEMI Japan on April 7, 2005. This action was subsequently approved by the I&C Global Coordinating Subcommittee by e-mail ballot on April 27, 2005 and by the Audit and Reviews Sub-Committee by ballot on May 21, 2005.

Note that Auxiliary Information is intended to be informational only, and is not to be considered a part of or a whole standard.

The information in this document has been furnished by the Equipment Supplier's Forum based on the common understanding within the forum member companies.

This document is intended to provide typical operation scenarios that reflect the experiences of Equipment Suppliers in the 300mm field and to facilitate them sharing under common understanding.

This document was developed by ESF¹ (Equipment Supplier's Forum) in March, 2005.

The intended use of the Auxiliary Information are as follows:

- (1) Provide common scenarios based on the SEMI 300mm standards,
- (2) Visualize operational variations defined in SEMI 300mm standards, and
- (3) Clarify the relationship between SEMI 300mm standards and contribute to identifying actual operational problems.

The SEMI Standards Program is publishing this document, as furnished by the Forum, so that it may be referenced by the industry, as desired. **No material in this document is to be construed as an official or adopted standard.** SEMI assumes no liability for the content of this document, which is the sole responsibility of the authors, nor for any errors or inaccuracies that may appear in this document. This

document may not be modified or changed without expressed written permission from SEMI.

SEMI grants permission to reproduce and distribute this document provided that

- (1) the document is maintained in its original form, and
- (2) the notice on the first page of the document accompanies the document at all times.

NOTICE: By publication of this document, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned herein. Users of this document are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

¹ ESF is a voluntary group of Equipment Suppliers and has been studying implementations and effective operations of the SEMI Standards.

The information in this document has been furnished by Equipment Supplier's Forum, operating outside of the SEMI Standards Activity, for informational use only and is subject to change without notice. The Semiconductor Equipment and Materials International (SEMI®) Standards Program is publishing this information as furnished by the group in the form of Auxiliary Information so that it may be referenced by the industry, as desired. **No material in this document is to be construed as an official or adopted standard.** SEMI assumes no liability for the content of this document, which is the sole responsibility of the authors, nor for any errors or inaccuracies that may appear in this document. SEMI grants permission to reproduce and distribute this document provided that

- (1) the document is maintained in its original form, and
- (2) this disclaimer and the notice below accompany the document at all times.

NOTICE: By publication of this document, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned herein. Users of this document are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility

Copyright 2005 by SEMI® (Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134). See above for information on limited rights for reproduction and distribution; all other rights reserved.

Equipment Supplier's Basic Operational Scenarios for Automation

Version 1.00

Equipment Supplier's Forum

March 7, 2005

Revision History

Version	Contents	Date
1.00	Version 1.00 release.	March 7, 2005

Table of Contents

1	Overview	1-1
1.1	Conceptual Relationships between Material and Processing	1-2
1.1.1	Conceptual Relationships between Material Transfer and Process Execution	1-2
1.1.2	Conceptual Relationships between Process Job and Control Job	1-3
1.1.3	Conceptual Relationships between Control Jobs	1-4
1.2	Conceptual Carrier Transfer Flow	1-5
1.2.1	Conceptual Carrier Load Transfer Flow	1-5
1.2.2	Conceptual Carrier Unload Transfer Flow	1-6
1.3	Conceptual Processing Flow	1-7
1.3.1	Job Creation Flow	1-7
1.3.2	Job Execution Flow	1-7
1.4	Conventions	1-8
1.4.1	Scenario Table	1-8
1.4.2	Abbreviations	1-9
1.4.3	How to Read Scenarios	1-11
2	Carrier Transfer Scenario for Fixed Buffer Equipment	2-1
2.1	Carrier Load Transfer Scenario	2-1
2.1.1	Carrier Load Transfer & ID Verification (Bind service)	2-3
2.1.2	Carrier Load Transfer & ID Verification (CarrierNotification service).....	2-6
2.1.3	Carrier Load Transfer & ID Verification (ReserveAtPort service).....	2-9
2.1.4	Carrier Dock & Open	2-12
2.1.5	Equipment Based Slot Map Verification.....	2-13
2.1.6	Host Based Slot Map Verification.....	2-14
2.2	Carrier Unload Transfer Scenario.....	2-15
2.2.1	Carrier Close.....	2-16
2.2.2	Carrier Close & Tag Access.....	2-17
2.2.3	Carrier Unload Transfer	2-18

3	Carrier Transfer Scenario for Internal Buffer Equipment.....	3-1
3.1	Carrier Load Transfer Scenario	3-2
3.1.1	Carrier Load Transfer & ID Verification (Bind service)	3-4
3.1.2	Carrier Load Transfer & ID Verification (CarrierNotification service).....	3-7
3.1.3	Carrier Load Transfer & ID Verification (ReserveAtPort service).....	3-10
3.1.4	Carrier Movement into Internal Buffer & Dock/Open.....	3-13
3.1.5	Equipment Based Slot Map Verification.....	3-15
3.1.6	Host Based Slot Map Verification.....	3-16
3.1.7	Carrier Movement to Store Location.....	3-18
3.2	Carrier Unload Transfer Scenario.....	3-19
3.2.1	Carrier Movement to Internal FIMS Port.....	3-21
3.2.2	Carrier Close.....	3-23
3.2.3	Carrier Unload Transfer	3-25
4	Processing (Job Creation and Execution)	4-1
4.1	Job Creation Scenario	4-1
4.1.1	PRJob Creation.....	4-2
4.1.2	Control Job Creation	4-3
4.2	Job Execution Scenario	4-4
4.2.1	Control Job Initiation.....	4-5
4.2.2	Control Job Completion	4-6
4.2.3	PRJob Execution	4-7

1 Overview

The purpose of this document is to provide typical operation scenarios based on mainly SEMI Standards E40 (Process Job), E94 (Control Job), and E87 (Carrier Management). This document does not contain Exception Handling because it addresses only scenarios during the normal operation when the Automated Material Transfer is used. Details of actual operation scenarios may be different from the scenarios described in this document due to the Equipment structure or the Equipment specifications.

Referenced Standards

- SEMI E30-1103
- SEMI E40-0304 and SEMI E40.1-0304
- SEMI E87-0304 and SEMI E87-0702
- SEMI E94-1104 and SEMI E94-1104

The operation scenarios are classified into main three parts in this document: “Carrier Transfer for Fixed Buffer Equipment”, “Carrier Transfer for Internal Buffer Equipment”, and “Job Creation and Execution”. Each part of the scenarios has variations due to operational options. The combination of these variation scenarios, based on actual operation requirements could provide a scenario that meets specific Equipment user’s operation requirements.

This chapter explains conceptual relationships between Material Transfer and Processing.

1.1 Conceptual Relationships between Material and Processing**1.1.1 Conceptual Relationships between Material Transfer and Process Execution**

This section describes the concept of the relationships between Material Transfer and Processing in the operations based on SEMI E40, E94, and E87.

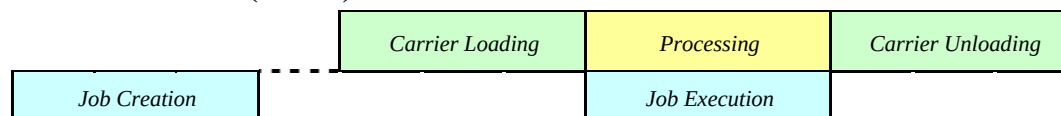
A processing is instructed by Process Job (E40) and Control Job (E94). A processing instructed by Jobs generally begins when the following two conditions are satisfied.

- Materials required for a processing arrive at the Equipment.
- Equipment resources required for a processing are available.

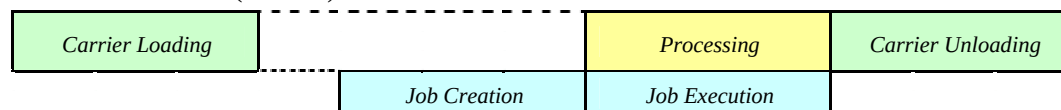
An Equipment user can choose whether a Job is created before or after a material arrival, according to the Equipment user's operational policy.

The conceptual relationships between Material Transfer to/from Equipment and Processing could be illustrated as the following figure.

Job Creation Before Carrier (Material) Arrival



Job Creation After Carrier (Material) Arrival



1.1.2 Conceptual Relationships between Process Job and Control Job

This section describes the concept of the relationships between Control Job (SEMI E94) and Process Job (SEMI E40).

Since Process Jobs are linked to a Control Job, the linked Process Jobs must be created before the Control Job creation.

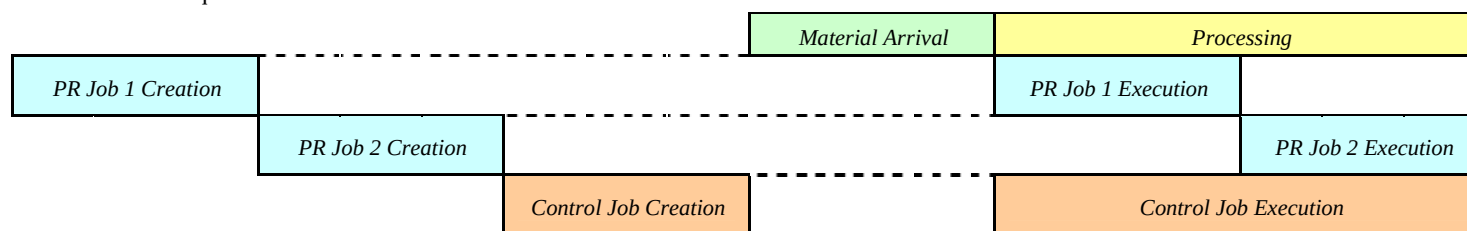
An execution order of the Process Jobs that are linked to the Control Job is specified in the Control Job settings. When the first Process Job in the execution order becomes available for its execution, the Control Job and the Process Job start. And then, the subsequent Process Job starts when it becomes available for its execution.

Whether multiple Process Jobs can be executed simultaneously depends on the Equipment specifications. When multiple Process Jobs are executed simultaneously, events are reported for each Process Job, based on each processing status. That is, from the Process Job's perspective, even when more than one Process Job is executed simultaneously, each Process Job performs processing independently.

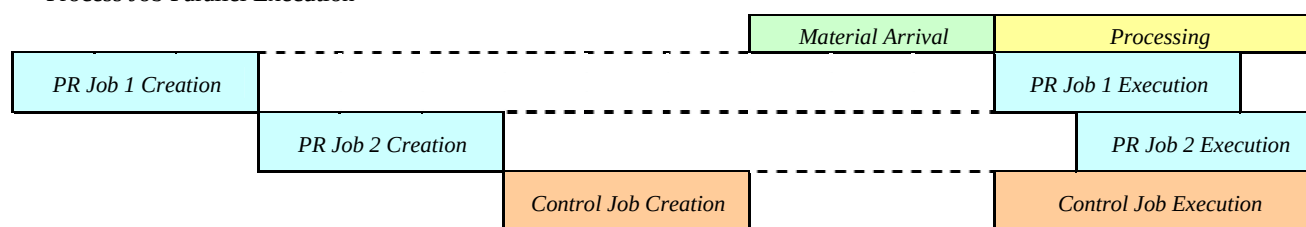
When all Process Jobs that are linked to the Control Job are completed, the corresponding Control Job is completed.

The conceptual relationships between the Process Job and the Control Job could be illustrated as the following figures.

Process Job Sequential Execution



Process Job Parallel Execution

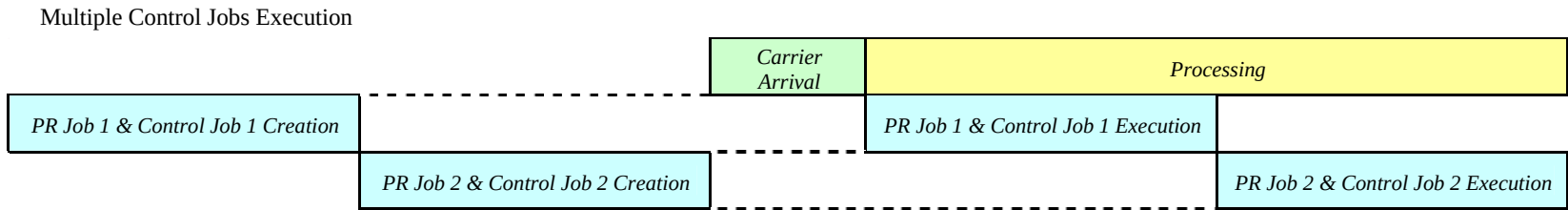


1.1.3 Conceptual Relationships between Control Jobs

This section describes the concept of the relationships between multiple Control Jobs that are linked to one carrier.

When multiple Control Jobs are linked to one carrier, each Control Job is executed independently from the Control Job perspective. Therefore, events are reported based on each Control Job processing status.

The conceptual relationships between multiple Control Jobs that are linked to one carrier could be illustrated as the following figure.

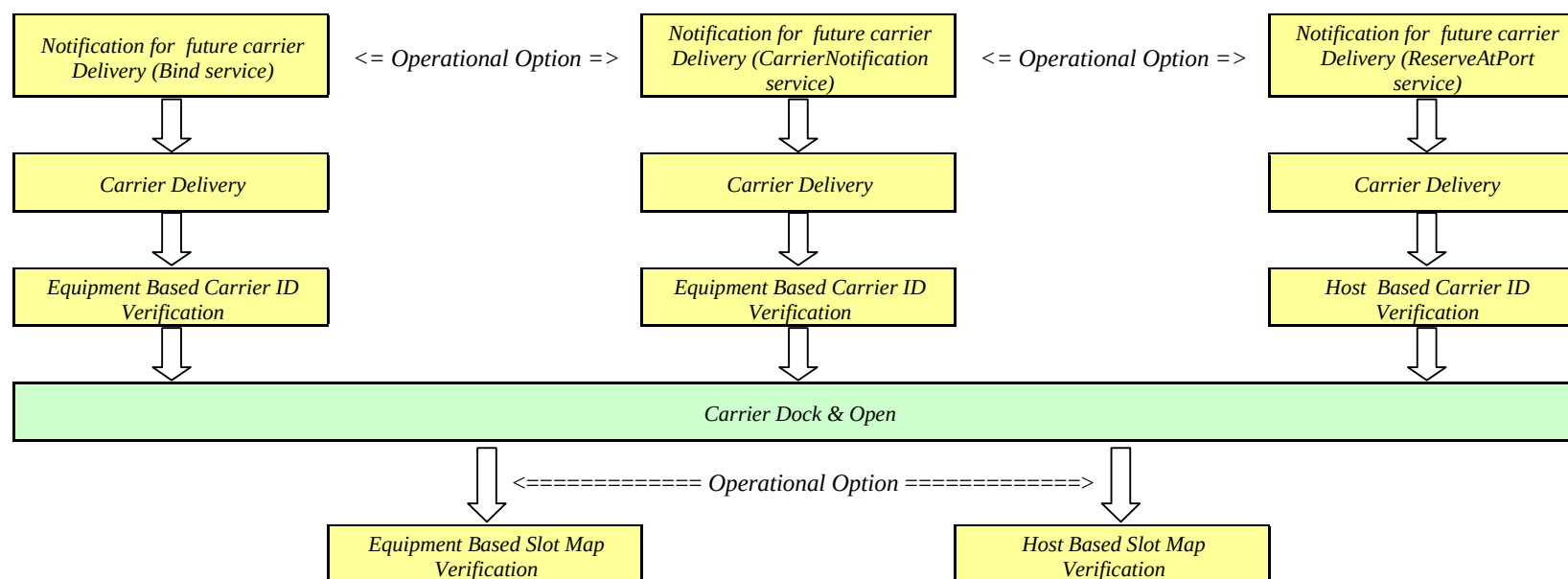


1.2 Conceptual Carrier Transfer Flow

There are several variations in Carrier Transfer to/from Equipment processes, depending on Equipment types, Equipment physical structures, and operations. This section describes these conceptual variations.

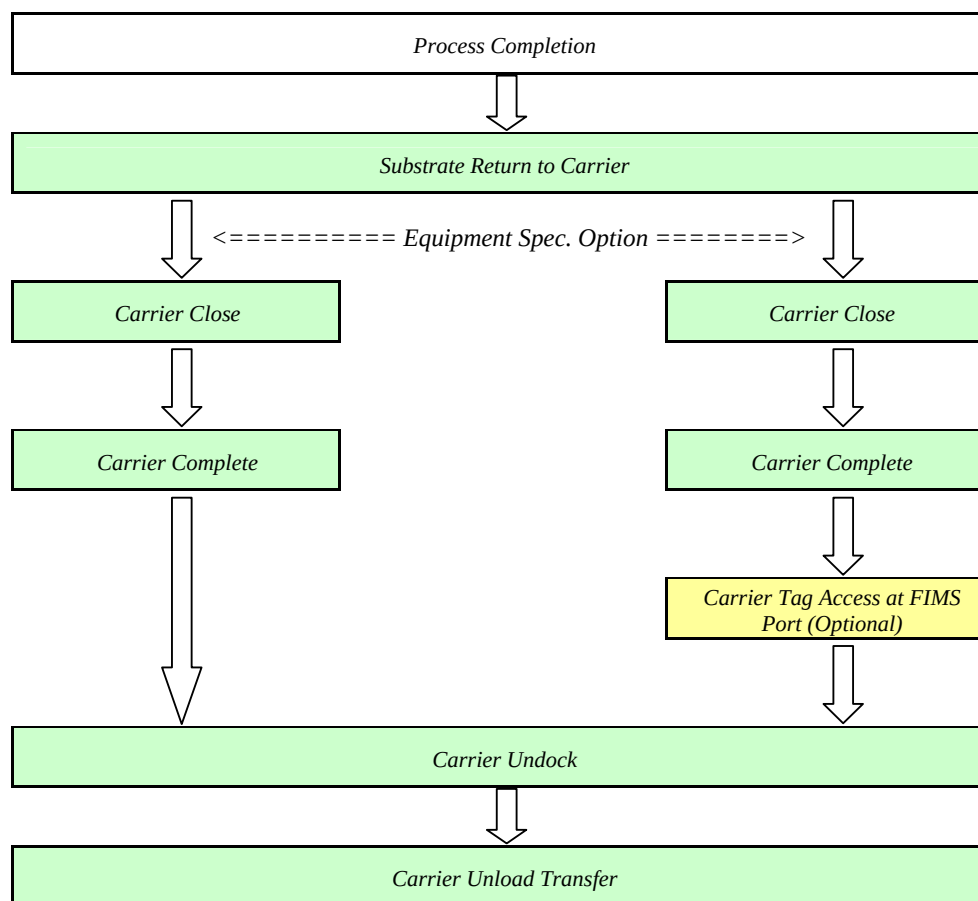
1.2.1 Conceptual Carrier Load Transfer Flow

Conceptual Carrier Load Transfer scenarios could be illustrated in the following flow chart. Note that this flow chart is generalized without considering the Equipment types and Equipment physical structures.



1.2.2 Conceptual Carrier Unload Transfer Flow

Conceptual Carrier Unload Transfer scenarios could be illustrated in the following flow chart. Note that this flow chart is generalized without considering the Equipment types and Equipment physical structures.



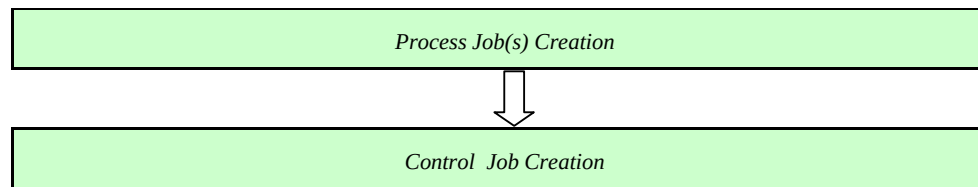
1.3 Conceptual Processing Flow

The Processing flow could be classified into two parts; the Job creation and the Job execution.

1.3.1 Job Creation Flow

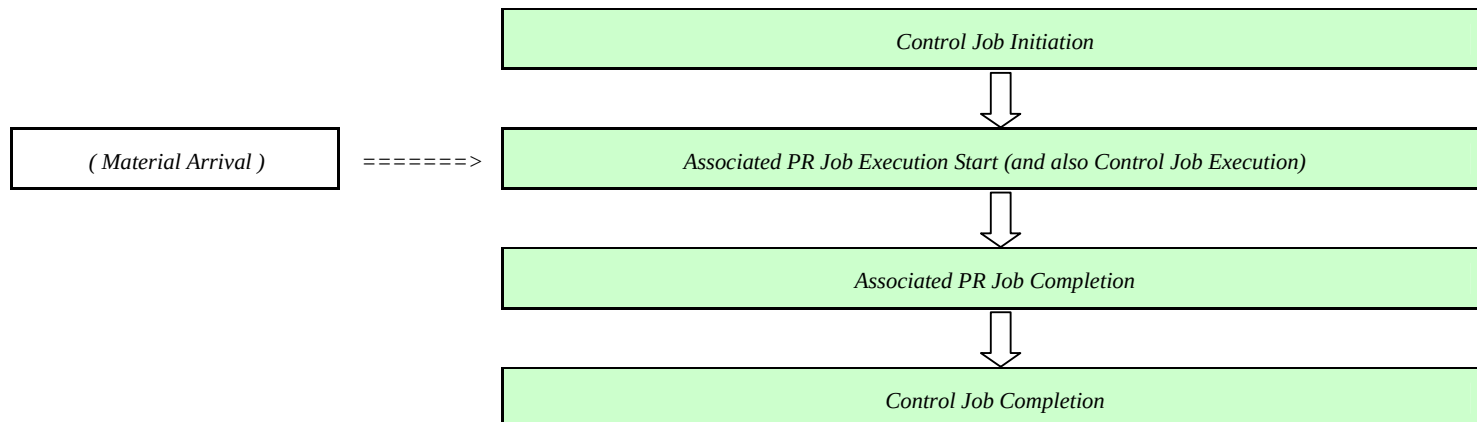
The Job creation flow is illustrated in the following flow chart.

The Job creation flow illustrates that the Process Jobs to be linked must be created before a Control Job creation.



1.3.2 Job Execution Flow

The Job execution flow is illustrated in the following flow chart. Note that this flow chart is illustrated without considering the number of Process Jobs.



1.4 Conventions**1.4.1 Scenario Table**

The scenarios in this document are described using a table format described in the following table.

No.	Host View	Primary Direction	SECS Message (SECS Desc)	Equipment Action & Behavior	State Model	State Model	State Model

- Host View

This column describes Equipment states from the Host view. Occurrences that the Host can not recognize are described in brackets.

- Primary Direction

The primary direction is indicated when SECS II messages are exchanged between the Host and the Equipment.

“H -> E” indicates that a primary message is sent from the Host to the Equipment.

“H <- E” indicates that a primary message is sent from the Equipment to the Host.

- SECS Message

This column describes SECS II messages between the Host and the Equipment. Service names and event names are described in brackets. For a state transition event report, a state (name) after a transition is described in brackets.

- Equipment Action & Behavior

This column describes an Equipment action or behavior, including state transitions of the state model that occur on the Equipment.

- State Model

States of each state model are described in such columns as LPTS and LRS to the right of Equipment Action & Behavior column, using the abbreviations in Section 1.5.2.

1.4.2 Abbreviations**Carrier Management Standard (E87)**

LPTS	: Load Port Transfer State Model	LRS	: Load Port Reservation State Model
RTL	: READY TO LOAD	NR	: NOT RESERVED
RTU	: READY TO UNLOAD	R	: RESERVED
TB	: TRANSFER BLOCKED		
OS	: OUT OF SERVICE		

LCAS	: Load Port/Carrier Association State Model
NA	: NOT ASSOCIATED
A	: ASSOCIATED

CIDS	: Carrier ID Status	CSMS	: Carrier Slot Map Status	CAS	: Carrier Accessing Status
INR	: ID NOT READ	SNR	: SLOT MAP NOT READ	NA	: NOT ACCESSED
WFH	: (ID) WAITING FOR HOST	WFH	: (SLOT MAP) WAITING FOR HOST	IA	: IN ACCESS
IVO	: ID VERIFICATION OK	SVO	: SLOT MAP VERIFICATION OK	CC	: CARRIER COMPLETE
IVF	: ID VERIFICATION FAILED	SVF	: SLOT MAP VERIFICATION FAIL	CS	: CARRIER STOPPED

Process Job Management Standard (E40)

PJS	: Process Job State Model				
Q/P	: QUEUED/POOLED	P	: PROCESSING	PG	: PAUSING
SU	: SETTING UP	PC	: PROCESS COMPLETE	PD	: PAUSED
WFS	: WAITING FOR START	STP	: STOPPING	A	: ABORTING

Control Job Management Standard (E94)

CJS : Control Job State Model

Q : QUEUED

S : SELECTED

WFS : WAITING FOR START

E : EXECUTING

P : PAUSED

C : COMPLETED

Equipment Supplier's Basic Operational Scenarios for Automation Version 1.00**1 Overview****1.4.3 How to Read Scenarios**

This section describes how to read scenarios by providing the following example.

< Example >

No.	Host View	Primary Direction	SECS Message (SECS Desc)	Equipment Action & Behavior	LPTS	LRS	LCAS	CIDS	CSMS	CAS
0	-----	-----	-----	(Equipment uses the carrier for processing.) Note that no Carrier Tag Reader/Writer is installed.	TB	NR	A	IVO	SVO	IA
Carrier Completion										
1	(Processing completes for the carrier.)	---	---	All the wafers return to the carrier and no processing is assigned to the wafers in the carrier.	TB	NR	A	IVO	SVO	IA
2	(The carrier door is closed and the carrier completes.)	---	---	Equipment closes the carrier door. (1) CAS transitions to CARRIER COMPLETE via transition #19.						CC
3	Equipment notifies Host that the carrier door has been Closed. ----- Equipment notifies Host that the carrier has completed.	H <- E ----- H <- E	S6F11/S6F12 (Carrier Closed) ----- S6F11/S6F12 (CARRIER COMPLETE)	Equipment sends a Carrier Closed event (E87). ----- Equipment sends a state transition event, CARRIER COMPLETE.						
Go to section 2.2.3, Unload Transfer.										

The No. 0 line describes the initial state when a scenario starts. For the example above, the Equipment Action & Behavior column describes that Equipment uses the carrier for processing.

“Carrier Completion” described above is a sub-title for better understanding.

Multiple events that occur simultaneously are described in the same line. Dashed lines may be used for identifying the multiple events. Such dashed line is used in the No.3 line of the example table. For No.3 of the table, the Carrier Closed event and the state transition event of Carrier Accessing Status are reported simultaneously. Actual reporting order of these two event reports is not necessarily the same as that described in the scenario.

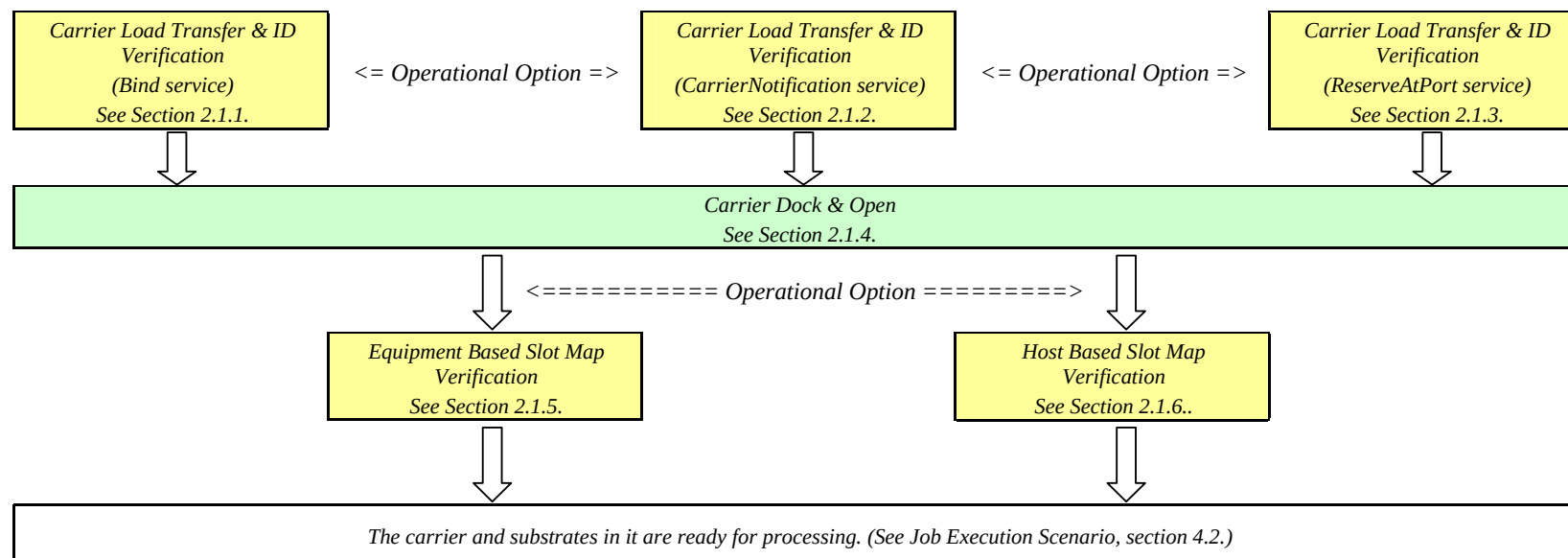
The last line of the example table describes conditions after the scenario completion. For the example above, the last line describes that the completed scenario is followed by another scenario described in Section 2.2.3 “Unload Transfer.”

2 Carrier Transfer Scenario for Fixed Buffer Equipment

This chapter describes Carrier Transfer Scenarios for the Fixed Buffer Equipment; Section 2.1 describes Carrier Load Transfer Scenarios and Section 2.2 describes Carrier Unload Transfer Scenarios.

2.1 Carrier Load Transfer Scenario

The Carrier Load Transfer Scenarios for the Fixed Buffer Equipment are classified into three main parts, Carrier Load Transfer & ID Verification, Carrier Dock & Open, and Slot Map Verification, as illustrated in the following flow chart:



- Carrier Load Transfer & ID Verification

The first part is the scenario from Carrier Transfer to ID Verification. This part has three variations depending on a Carrier Delivery notification method.

- Carrier Dock & Open

The second part is the scenario from Carrier Dock to Carrier Open. Generally, this part has no variation.

- Slot Map Verification

The last part is the scenario of Slot Map Verification. This part has two variations depending on the Verification method.

For example, if an operational scenario is required where the Carrier Delivery notification through a Bind service and Host Based Slot Map Verification are performed, the scenario can be constructed by combining the scenarios in Section 2.1.1, 2.1.4, and 2.1.6 as described in the chart above.

Equipment Supplier's Basic Operational Scenarios for Automation Version 1.00**2 Carrier Transfer Scenarios for Fixed Buffer Equipment****2.1.1 Carrier Load Transfer & ID Verification Scenario (Bind service)**

This scenario describes a situation where the Carrier Delivery notification and the load port reservation are performed through the Bind service.

No.	Host View	Primary Direction	SECS Message (SECS Desc)	Equipment Action & Behavior	LPTS	LRS	LCAS	CIDS	CSMS	CAS
0	-----	-----	-----	(Load port is available for Carrier Load Transfer.)	RTL	NR	NA	no state	no state	no state
Notification and Reservation for Future Carrier Delivery										
1	Host sends a ChangeAccess service with the value of AUTO to secure successful Carrier Transfer via AMHS.	H -> E	S3F27/S3F28 (ChangeAccess)	Equipment accepts the ChangeAccess service. (1) If the load port is already AUTO, the equipment returns a positive reply. (The Access Mode of the load port remains AUTO.) (2) If the load port is MANUAL, the equipment returns a positive reply and the Access Mode state transitions to AUTO via Transition #2.	RTL	NR	NA	no state	no state	no state
2	Only if the Access Mode transitions to AUTO. Equipment notifies Host that the load port is available for AMHS transfer.	H <- E	S6F11/S6F12 (AUTO)	Equipment sends a state transition event, AUTO, if a state transition occurs in Access Mode State.						
3	Host sends a Bind service for future carrier delivery by AMHS. <i>Note 1</i> <i>If Slot Map is provided by the Bind service, Equipment Based Slot Map Verification is performed.</i> <i>Note 2</i> <i>If Content Map is provided by the</i>	H -> E	S3F17/S3F18 (Bind)	Equipment accepts the Bind service. ----- Equipment reserves the load port for future carrier delivery. (1) LRS transitions to RESERVED via Transition #2. (2) Note that Access Mode of the load port is frozen during RESERVED. -----		R	A	INR	SNR	NA

Equipment Supplier's Basic Operational Scenarios for Automation Version 1.00

2 Carrier Transfer Scenarios for Fixed Buffer Equipment

No.	Host View	Primary Direction	SECS Message (SECS Desc)	Equipment Action & Behavior	LPTS	LRS	LCAS	CIDS	CSMS	CAS
	Bind service, Equipment instantiates substrate objects with provided Substrate IDs in Content Map.			Equipment instantiates the carrier object with the provided Carrier ID. (1) CIDS transitions to ID NOT READ via transition #2. (2) CSMS transitions to SLOT MAP NOT READ via transition #12. (3) CAS transitions to NOT ACCESSED via transition #17. Equipment associates the load port with the carrier. (1) Load Port/Carrier Association State (LCAS) transitions to ASSOCIATED via Transition #2.						
4	Equipment notifies Host that the load port has been reserved.	H <- E	S6F11/S6F12 (RESERVED)	Equipment sends a state transition event, RESERVED.						
	Equipment notifies Host that the carrier object with the Carrier ID provided has been instantiated.	H <- E	S6, F11/F12 (ID NOT READ)	Equipment sends a state transition event, ID NOT READ.						
	Equipment notifies Host that the load port has been associated with the carrier.	H <- E	S6, F11/F12 (ASSOCIATED)	Equipment sends a state transition event, ASSOCIATED.						
Carrier Load Transfer										
5	(AMHS arrives at the load port and Carrier Load Transfer begins.)	---	---	Equipment begins carrier load transfer sequence. (1) LPTS transitions to TRANSFER BLOCKED via Transition #6.	TB	R	A	INR	SNR	NA
6	Equipment notifies Host that the carrier transfer has been started.	H <- E	S6F11/S6F12 (TRANSFER BLOCKED)	Equipment sends a state transition event, TRANSFER BLOCKED.						
7	(Carrier Load Transfer completes.)	---	---	Equipment clears the load port reservation. (1) LRS transitions to NOT RESERVED via Transition #3. Equipment clamps the carrier.		NR				

Equipment Supplier's Basic Operational Scenarios for Automation Version 1.00**2 Carrier Transfer Scenarios for Fixed Buffer Equipment**

No.	Host View	Primary Direction	SECS Message (SECS Desc)	Equipment Action & Behavior	LPTS	LRS	LCAS	CIDS	CSMS	CAS
8	Equipment notifies Host that the load port reservation has expired at the load port.	H <- E	S6F11/S6F12 (NOT RESERVED)	Equipment sends a state transition event, NOT RESERVED.						
	Equipment notifies Host that the carrier has been clamped.	H <- E	S6F11/S6F12 (Carrier Clamped)	Equipment sends a Carrier Clamped event (E87).						
	Equipment notifies Host of material (i.e. carrier) arrival at the load port.	H <- E	S6F11/S6F12 (Material Received)	Equipment sends a Material Received event (E30).						
Carrier ID Reading (Carrier ID Verification)										
9	(Carrier ID is read.)	- - -	- - -	Equipment successfully reads Carrier ID from the carrier. And the read Carrier ID equals one provided by the precedent Bind service. (1) CIDS transitions to ID VERIFICATION OK via transition #6.	TB	NR	A	IVO	SNR	NA
10	Equipment notifies Host of the successful carrier ID verification.	H <- E	S6, F11/F12 (ID VERIFICATION OK)	Equipment sends a state transition event, ID VERIFICATION OK.						
Go to section 2.1.4, Carrier Dock & Open.										