

AGV-AGVC COMMUNICATION
COMMON SPECIFICATION VER 1.6

Name of project		Common
System - Function		
Methodology	Stage	Definite Business Process
	Step	Definite Operation Scenario
No. of paper		

Ad mis sio n	PL	QA	PM

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- Revision History -

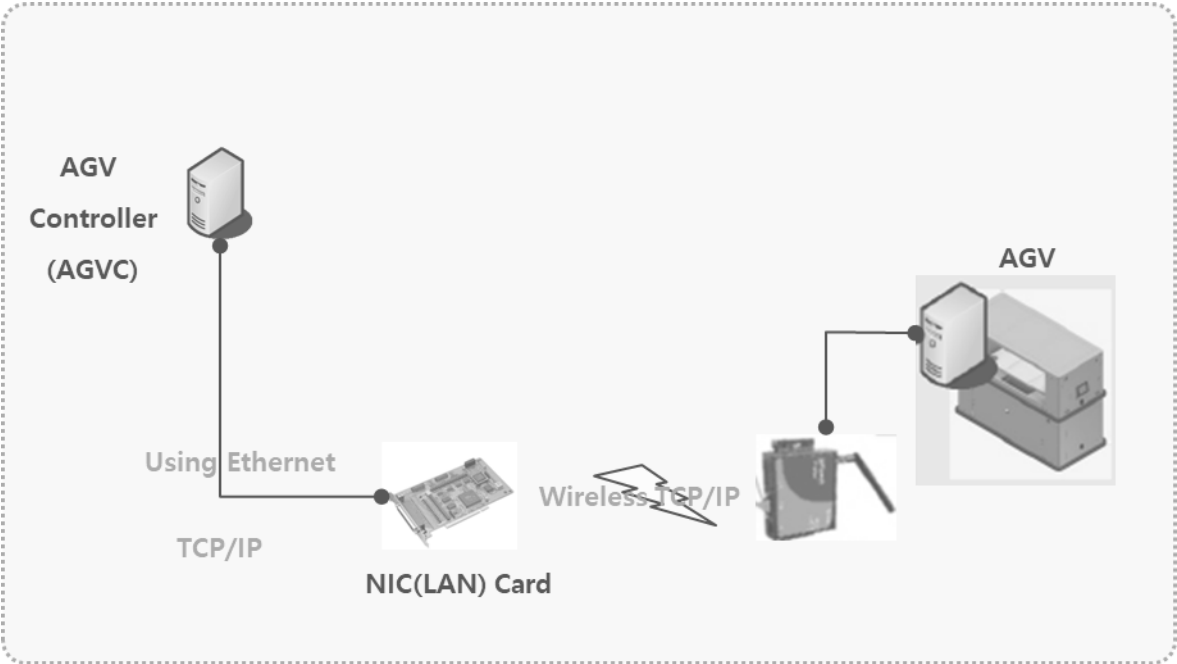
Version	Date of Issue	Contents	Issuer
1.0	2020-02-21	<ul style="list-style-type: none"> Make common specification 	An Ki Hyung
1.0	2020-04-24	<ul style="list-style-type: none"> Add Map Format 	An Ki Hyung
1.0	2020-07-08	<ul style="list-style-type: none"> (8page) Add Transfer Command Rotation angle (11page) Add Battery SoC at Status Data Report (12,13page) Modify definite of AGV Canceled Alarm (18-20page) Change Map Format 	An Ki Hyung
1.0	2020-07-23	<ul style="list-style-type: none"> (8page) Add Turn Command (13page) Add AGV Direction Status Spec (20page) Add Map Link Any Type 	An Ki Hyung
1.1	2020-07-30	<ul style="list-style-type: none"> (16page) Add Turn Scenario (20page) Add Layout Design (Derailment error condition,...) 	An Ki Hyung
1.2	2021-01-14	<ul style="list-style-type: none"> (8page) Remove unused command code (11page) Status Data Report has been changed. (12page) Remove unused status data (22page) Change Map Format (Add Link Num) 	An Ki Hyung
1.3	2021-02-23	<ul style="list-style-type: none"> (9page) Transfer Data Size Changed (100byte → 50byte) (11page) Dest Node report rule changed (22page) Map format changed (LINK) (26-28page) Appendix added 	An Ki Hyung
1.4	2021-02-26	<ul style="list-style-type: none"> (12,14page) HaveCmd interlock condition added 	An Ki Hyung
1.5	2021-03-02	<ul style="list-style-type: none"> (11page) Add ETC column in status data (11page) Add node/link report spec in case of manual mode 	An Ki Hyung
1.6	2021-03-03	<ul style="list-style-type: none"> (12) Add 'Active' spec (13) Add detailed comments for 'ENTERMAP' 	An Ki Hyung

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1. System Format

1.1 Vehicle Network



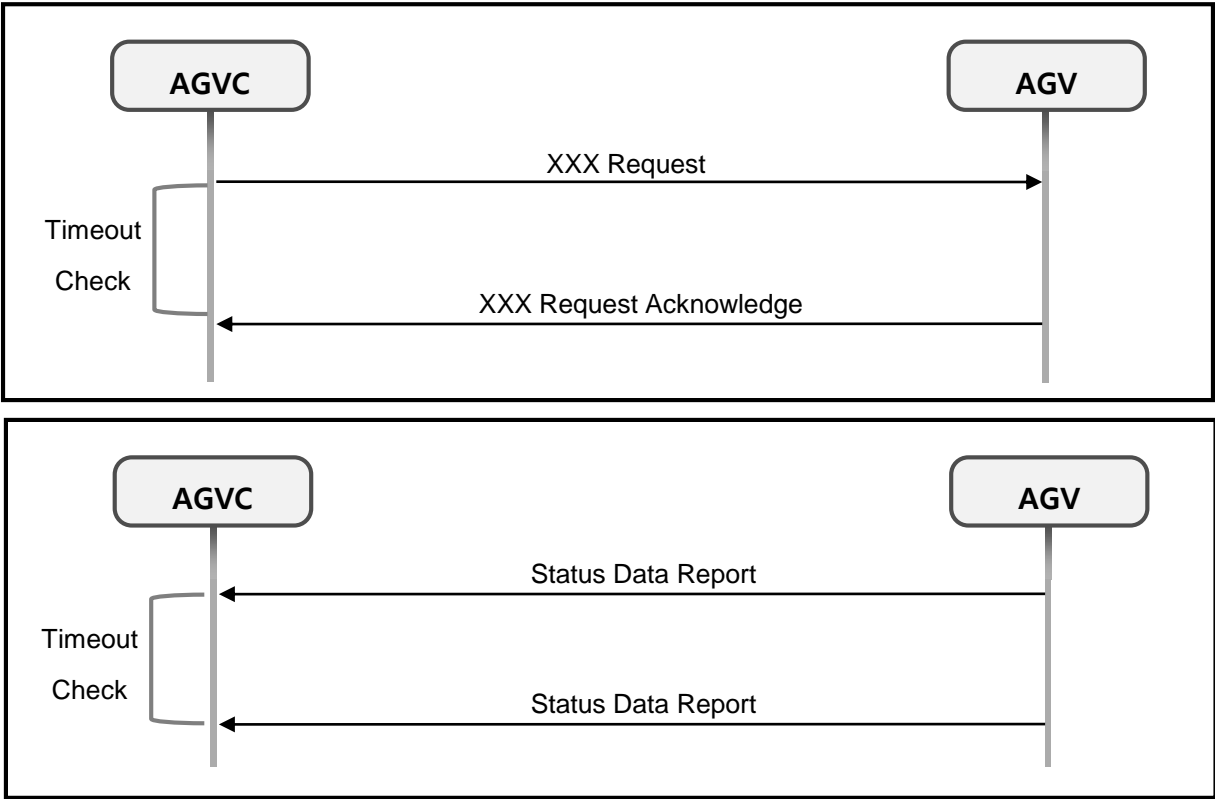
1.2 Network Specification

Item	Specification

2. Communication Format

2.1 Sequence

- Requirement about ACGV's Request, AGV has to response within T3, If there is no Response message, turn into Time-out
- Requirement about the periodical message from AGV, If there is no report within T10, turn into Time-out.
- When Time-out occurred, Retry as many times as set. If Time-out occurred continuously, Turn into Communication Alarm.



2.2 Message

- The message exchanged between AGVC and AGV construction is Header, Message's content, Tail.
- Display Ascii with Capital letter.
- Display Int with integer type such as 1byte or 2byte, Not including negative number.
- Header of Request & Header of Acknowledge are identical.
- CRFL is not included in Message.
- Tail is 'E' in common.

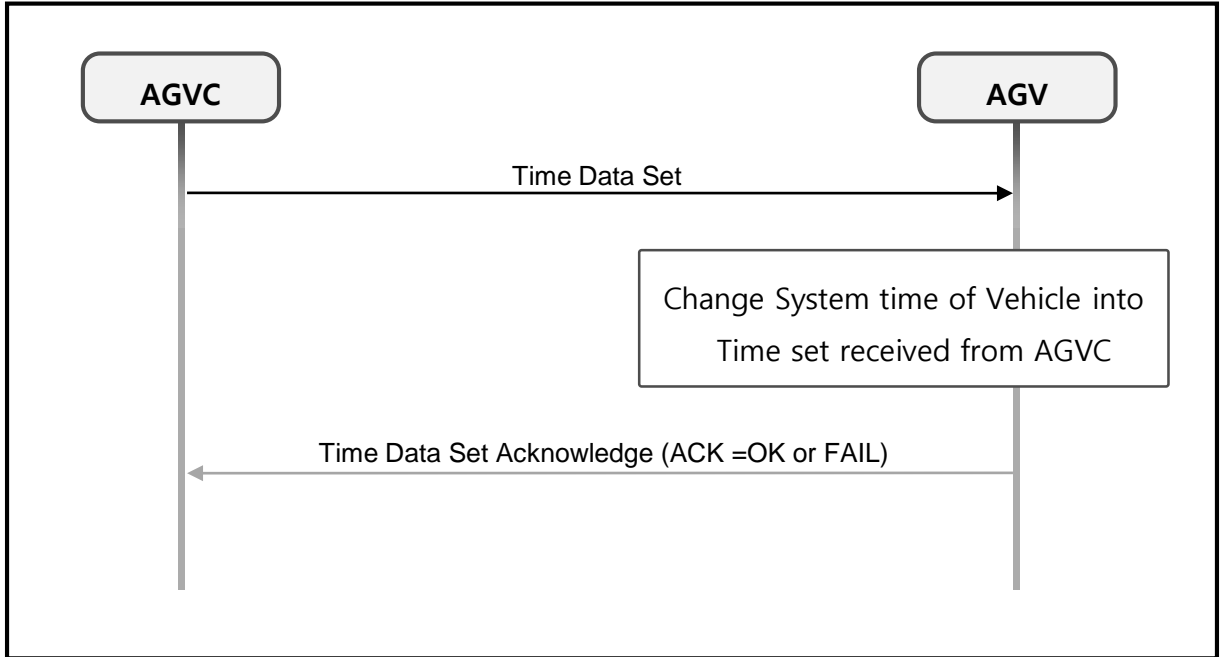
	Low Byte		High Byte
	▼		▼
Message	Header	Message	Tail
Size	1byte	N byte	1byte
Data Type	Ascii	Ascii / Int / Bit Array / Int Array	Ascii

3. Communication Spec

3.1 Time Data Send

- AGVC's time & AGV's time Synchronous message
Message báo đồng bộ AGVC's time với AGV's time

3.1.1 Sequence



3.1.2 Message

Time Data Set

Message	Header	Time Data	Tail
Size	1byte	14byte	1byte
Data Type	Ascii	Ascii	Ascii

- Header : 'T'
- Time Data : YYYYMMDDHHmmSS
- Tail : 'E'

Time Data Set Acknowledge

Message	Header	Tail
Size	1byte	1byte
Data Type	Ascii	Ascii

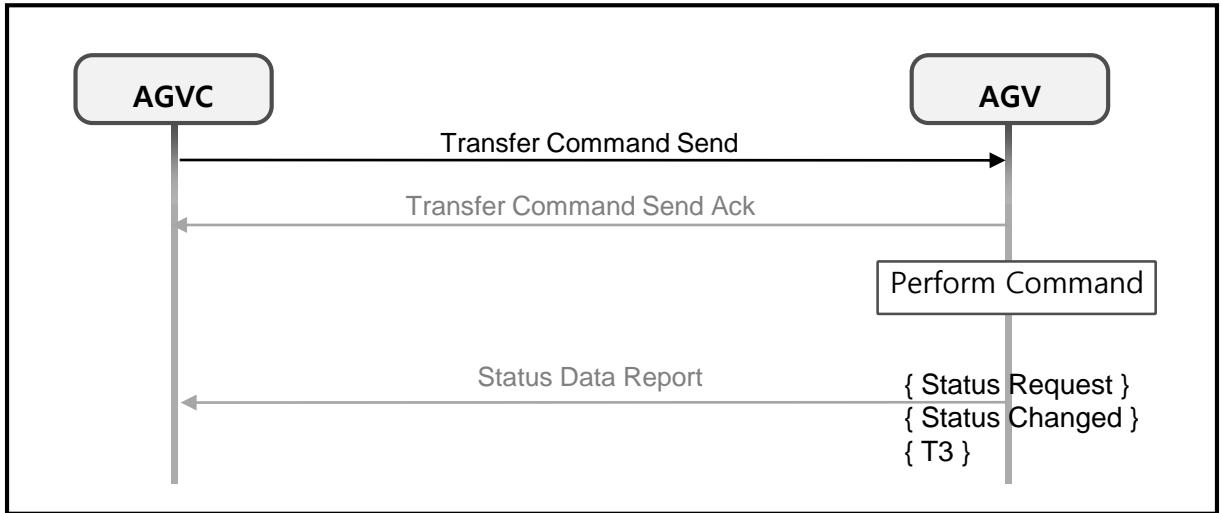
- Header : 'T'
- Tail : 'E'

3. Communication Spec

3.2 Transfer Command Send

- Message which transfers Command to Vehicle

3.2.1 Sequence



3.2.2 Message

Transfer Command Send (AGVC → AGV)

Message	Header	Vehicle ID	Command Code	Carrier ID	Via Node	Tail
Size	1byte	1byte	4byte	10byte	60byte	1byte
Data Type	Ascii	Int	Bit Array	Ascii	Int Array	Ascii

- Header : 'C'
- Vehicle ID : AGV No
- Command Code : Command code that will be sent to AGV
- Carrier ID : Carrier ID that will be return
- Via Node : AGVC sends the move command including nodes to be routed. (Max 15 nodes)
Each node's size is 4byte (4byte * 15 = 60byte)
- Tail : 'E'

Transfer Command Send Ack (AGV → AGVC)

Message	Header	Vehicle ID	Tail
Size	1byte	1byte	1byte
Data Type	Ascii	Int	Ascii

- Header : 'C'
- Vehicle ID : AGV No
- Tail : 'E'

※ If it is impossible to perform Command from AGVC, AGV should raise an alarm

3. Communication Spec

3.2.3 Command Code (3 열)

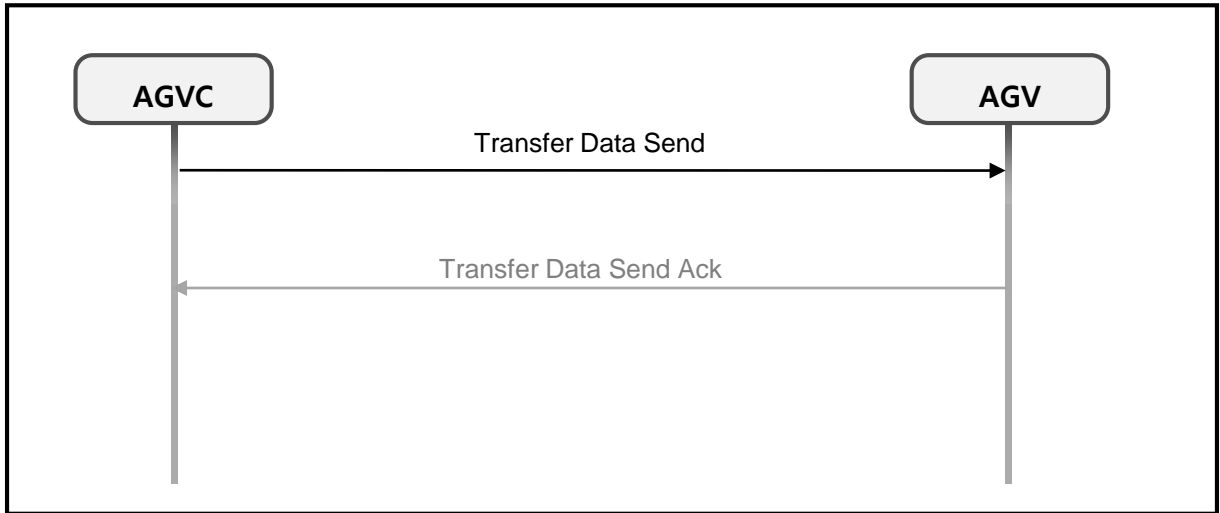
Byte	Bit	Command	Description
0 th	0	TRANSFER	
	1	MOVE	Moving
	2	ACQUIRE	Loading (from port)
	3	DEPOSIT	Unloading (to port)
	4	CHARGE	Charging
	5	TURN	Turning
	6	Not Reserved	-
	7	Not Reserved	-
1 st	0	Not Reserved	-
	1	Not Reserved	-
	2	Not Reserved	-
	3	Not Reserved	-
	4	STOP	Force to stop
	5	CHARGE STOP	Stop charging
	6	Not Reserved	
	7	Not Reserved	-
2 nd	0	LEFT	Uploading/Unloading Docking Location (Left)
	1	RIGHT	Loading/Unloading Docking Location (Right)
	2	FRONT	Uploading/Unloading Location (Front)
	3	REAR	Uploading/Unloading Location (Back)
	4	LOW	Uploading/Unloading Location (Low - Dưới)
	5	HIGH	Uploading/Unloading Location (High - Trên)
	6	Not Reserved	-
	7	Not Reserved	-
3 rd (Specific)	0	LEFT	Turn Left
	1	RIGHT	Turn Right
	2	Turn 90 Degree	Turn 90 Degree
	3	Turn 180 Degree	Turn 180 Degree
	4	Not Reserved	-
	5	Not Reserved	-
	6	Not Reserved	-
	7	Not Reserved	-

3. Communication Spec

3.3 Transfer Data Send

- Message that transfer to Data to Vehicle

3.3.1 Sequence



3.3.2 Message

Transfer Data Send (AGVC → AGV)

Message	Header	Vehicle ID	Data	Tail
Size	1byte	1byte	50byte	1byte
Data Type	Ascii	Int	Misc	Ascii

- Header : 'D'
- Vehicle ID : AGV No
- Data : Data that will be sent to AGV
- Tail : 'E'

Transfer Command Send Ack (AGV → AGVC)

Message	Header	Vehicle ID	Tail
Size	1byte	1byte	1byte
Data Type	Ascii	Int	Ascii

- Header : 'D'
- Vehicle ID : AGV No
- Tail : 'E'

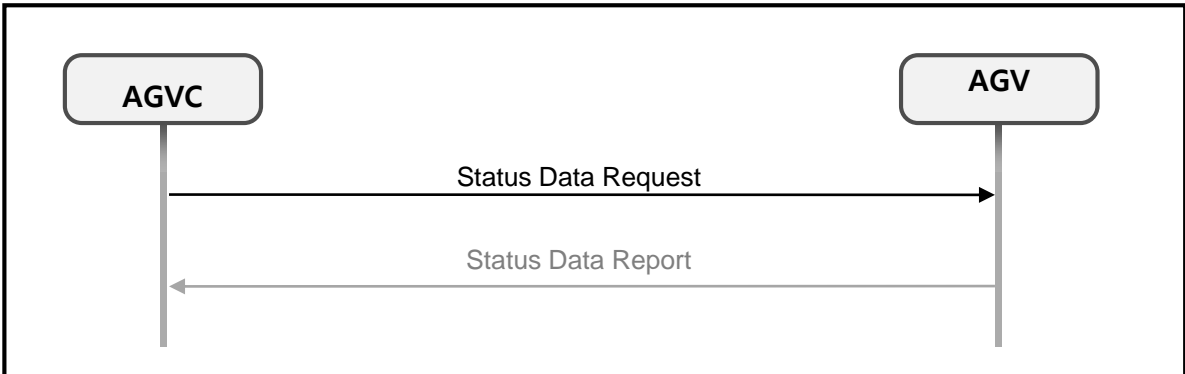
3. Communication Spec

3.4 Status Data Request & Report

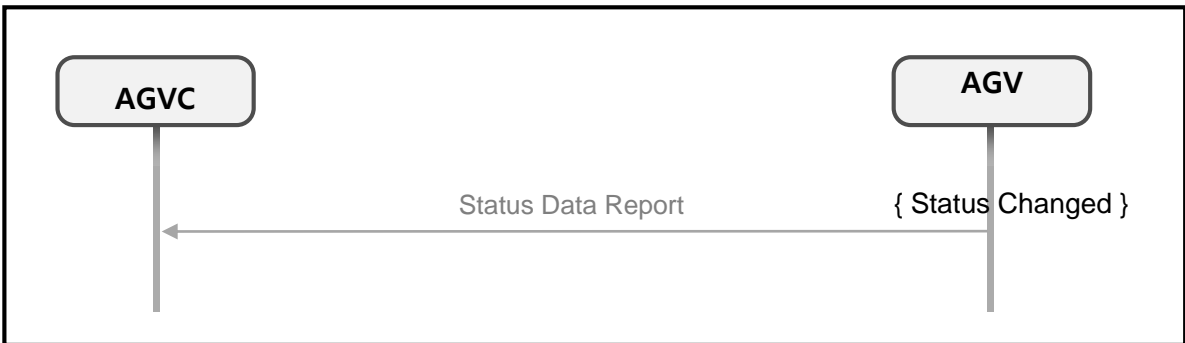
- Report AGV current status to AGVC.

3.4.1 Sequence

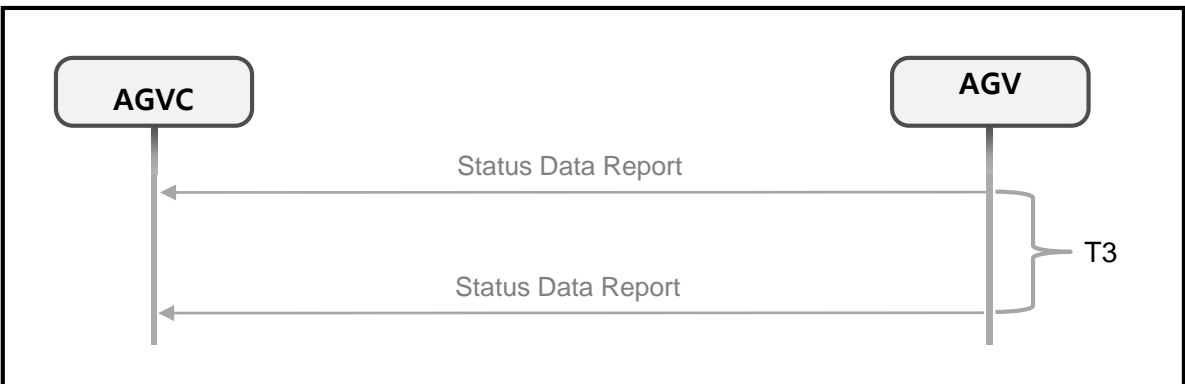
1) Status Data Request (AGVC → AGV, AGV → AGVC) : Status request from AGVC



2) Status Data Report (AGV → AGVC) : Report when AGV's status is changed



3) Status Data Report (AGV → AGVC) : Report every 3 sec periodically



※ 3) is not essential. It can be changed by 1) after discussion

3. Communication Spec

3.4.2 Message

Status Data Request (AGVC → AGV)

Message	Header	Vehicle ID	Tail
Size	1byte	1byte	1byte
Data Type	Ascii	Int	Ascii

- Header : 'S'
- Vehicle ID : AGV No
- Tail : 'E'

Status Data Report (AGV → AGVC)

Message	Header	Vehicle ID	Node	Link	Batt. Volt	Batt. Soc	Status	Event	Error (1-3)	Dest Node	Carrier ID	Map Version	ETC	Tail
Size	1byte	1byte	4byte	4byte	2byte	1byte	4byte	2byte	6byte	4byte	10byte	4byte	20byte	1byte
Data Type	Ascii	Int	Int	Int	Int	int	Bit Array	Int	Int Array	Int	Ascii	int	Misc	Ascii

※ Status Data Report of Vehicle has to be occurred when the blue zone is changed

- Header : 'S'
- Vehicle ID : AGV No
- Node : Node ID where AGV is located currently (Keep this Node ID until AGV arrives the next Node)
If AGV is in manual mode, node/link is the last position before manual changes.
- Link : Link Number where AGV is located currently
Link Number is a combination of "FROM NODE ID" and "TO NODE ID"
→ FROM * 10000 + TO
Example) 111(From) * 10000 + 112(To) = "1110112"
In case AGV stops at Node, entry Link when AGV arrived current Node
In case AGV is moving, Link between Start Node to End Note
In case AGV's power is OFF - ON, entry link of the node that AGV forwards to
- Batt. Volt : AGV Battery Voltage
- Batt. Soc : AGV Battery Percentage (0~100%)
- Status : AGV current status (Consult next page - Tham khảo page sau)
- Event : Event about AGV's additional status
- Error : AGV's Alarm status (Maximum 3 : 2byte * 3)
- Dest Node : Destination node that is the last one of receiving nodes from AGVC.
→ If AGV status is idle (has no command), dest node is "current node".
- Map Version : Map Version information
- Carrier ID : Carrier ID of which one conveying/loading goods
- ETC : AGV's additional information
- Tail : 'E'

3. Communication Spec

3.4.3 Status Data (6열)

Byte	Bit	Status	Description
0 th	0	Moving	Moving
	1	Arriving	<ul style="list-style-type: none"> AGV is soon arriving the destination node (last one of receiving nodes from AGVC) AGVC sends next nodes if the agv sends arriving signal. It has to be possible to move next nodes while moving in constant velocity (not to stop)
	2	Acquiring	Unloading (from port)
	3	Depositing	Loading (to port)
	4	Charging	Is in charging progress
	5	Manual Mode	Manual Mode Status
	6	Down	Down Status
	7	Active	If AGV is possible to run, set this bit '1(on)'. → AGV is not manual mode, and not down
1 st	0	HaveCmd	AGV has a command being executed. If AGV has a command being executed, AGV should ignore new command from AGVC except below case. (Don't use queue) [Exception Case] While AGV is moving and in arriving status, If AGVC sends next MOVE Command, AGV should accept the command,
	1	Canceled	Performing command is cancelled (PIO Valid Timeout) - AGV deleted Command by itself - ※ If Canceled: ON -> HaveCmd: OFF Change into Manual mode or If other command occurred, Canceled: OFF
	2	Job Finished	Command completed (un/uploading) ※ Job Finished: ON -> HaveCmd: OFF When other command occurred, Job Finished: OFF
	3	ChargeArmOut	Charge Coupler Arm Out
	4	Loaded1	Goods Detection Status at 1th Station
	5	Loaded2	Goods Detection Status at 2th Station
	6	Loaded3	Goods Detection Status at 1th Station
	7	Loaded4	Goods Detection Status at 1th Station

→ Next Page

3. Communication Spec

3.4.3 Status Data (6열)

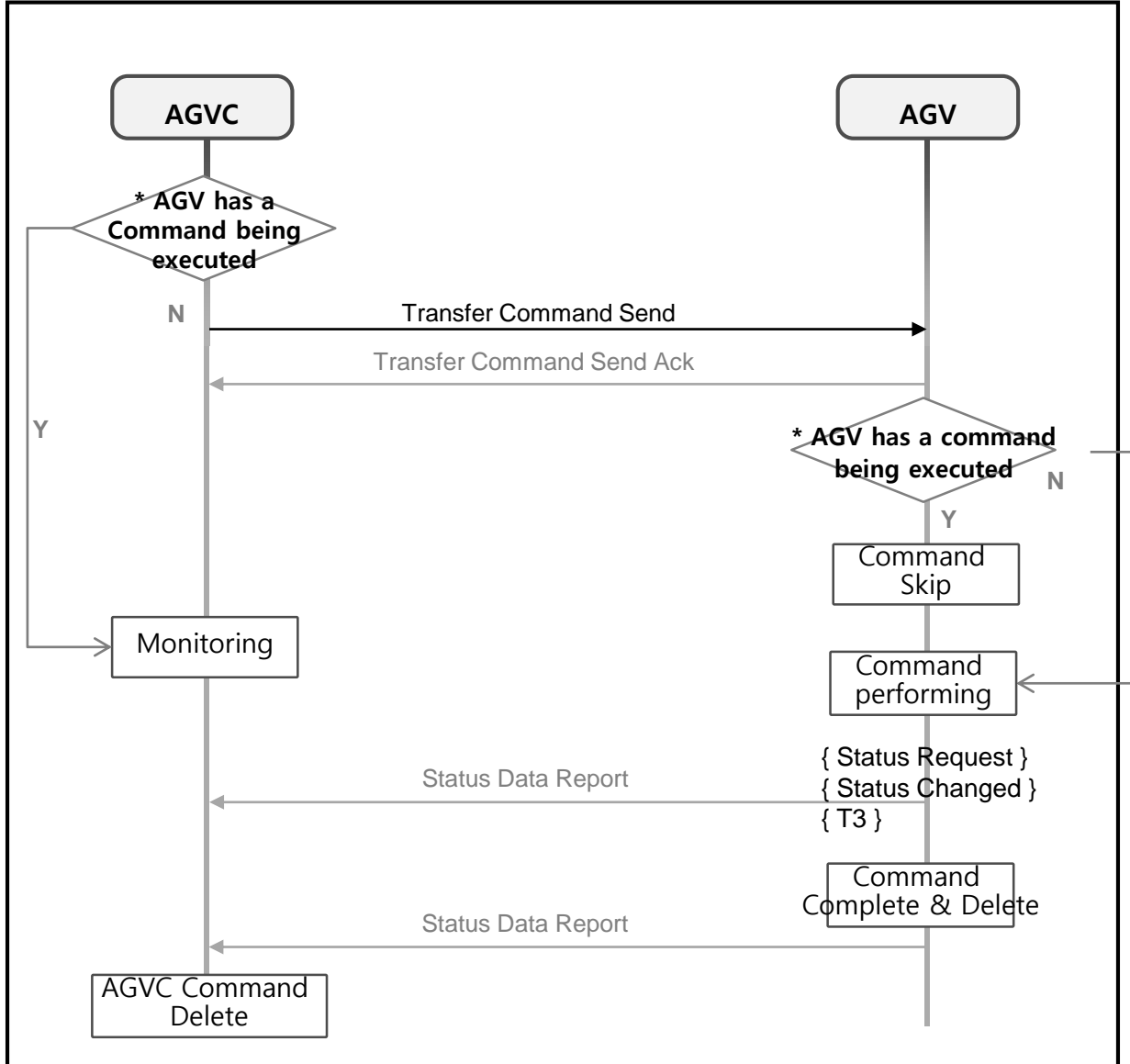
Byte	Bit	Status	Description
2 nd	0	Not Reserved	-
	1	Not Reserved	-
	2	ENTER MAP	AGV is Activated status at Layout If AGV needs to be out of layout, set this bit '0(off)'. If not, this bit always be set to '1(on)'
	3	Not Reserved	-
	4	Not Reserved	-
	5	Not Reserved	-
	6	Not Reserved	-
	7	Not Reserved	-
3 rd (Specific)	0	Direction (East)	Vehicle is in the East direction
	1	Direction (West)	Vehicle is in the West direction
	2	Direction (South)	Vehicle is in the South direction
	3	Direction (North)	Vehicle is in the North direction
	4	Not Reserved	-
	5	Not Reserved	-
	6	Not Reserved	-
	7	Not Reserved	-

4. Scenarios

4.1 Transfer Command Send (Common)

- Command transfer's Scenario to Vehicle

[Sequence]



1) If AGV receives new command from AGVC while executing a command, cancel new command message and keep executing command that existing. (except 12page "HaveCMD" case)

2) When AGV is performing command, it won't delete Command basically, except some cases/conditions as below:

- If it is changed into Manual or Local Mode, Delete Command (Canceled Bit OFF)
- When PIO Valid Time-out occurred, Delete Command (Canceled Bit ON)
- When Command Completed, Delete Command

※ When Stop or Alarm occurred, Command won't be Delete except the cases/conditions as above

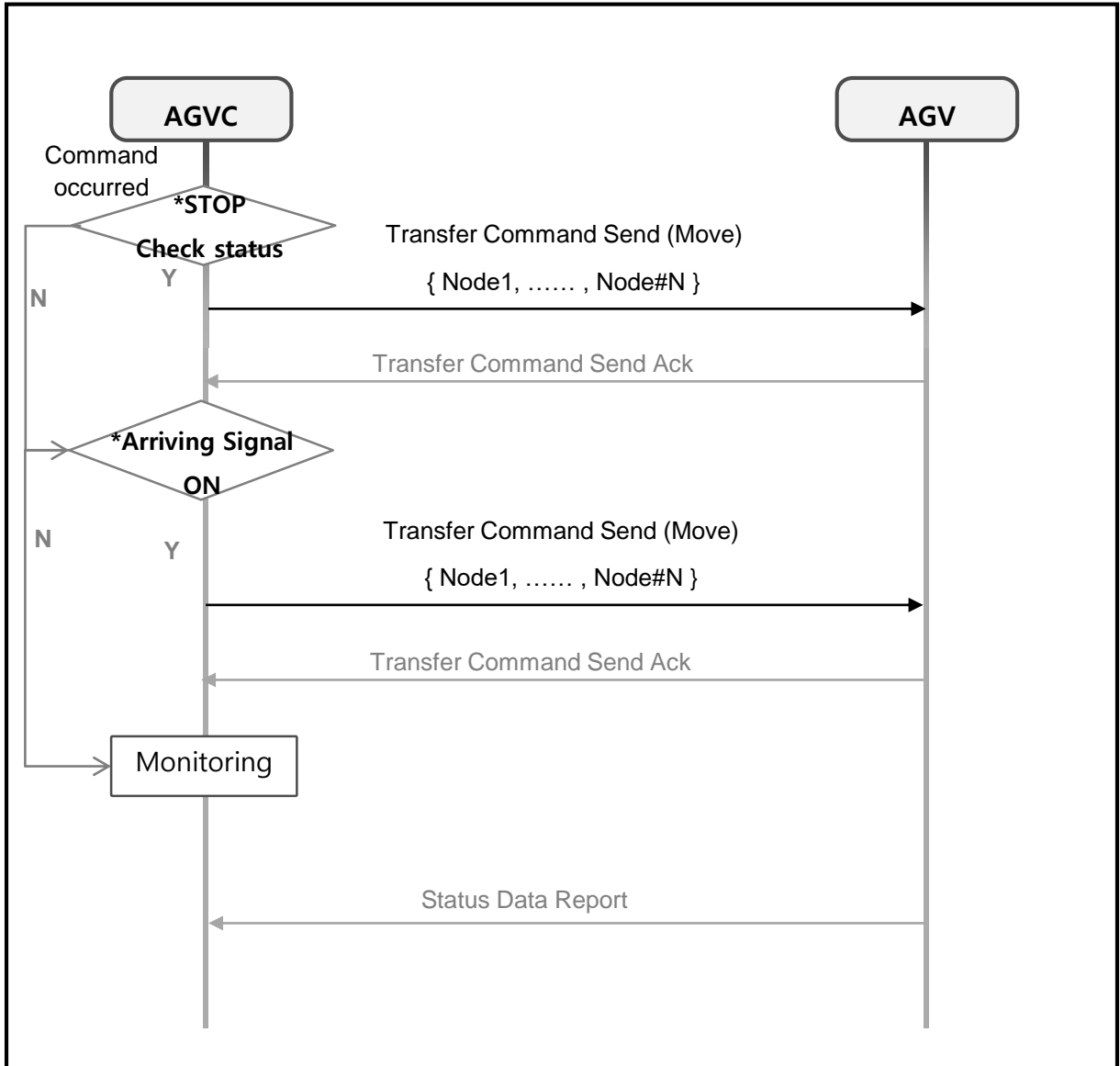
3) Time-Out & Retry follows Communication Common Format

4. Scenarios

4.2 Transfer Command Send (Move)

- Move Command transfer's Scenario to Vehicle

[Sequence]



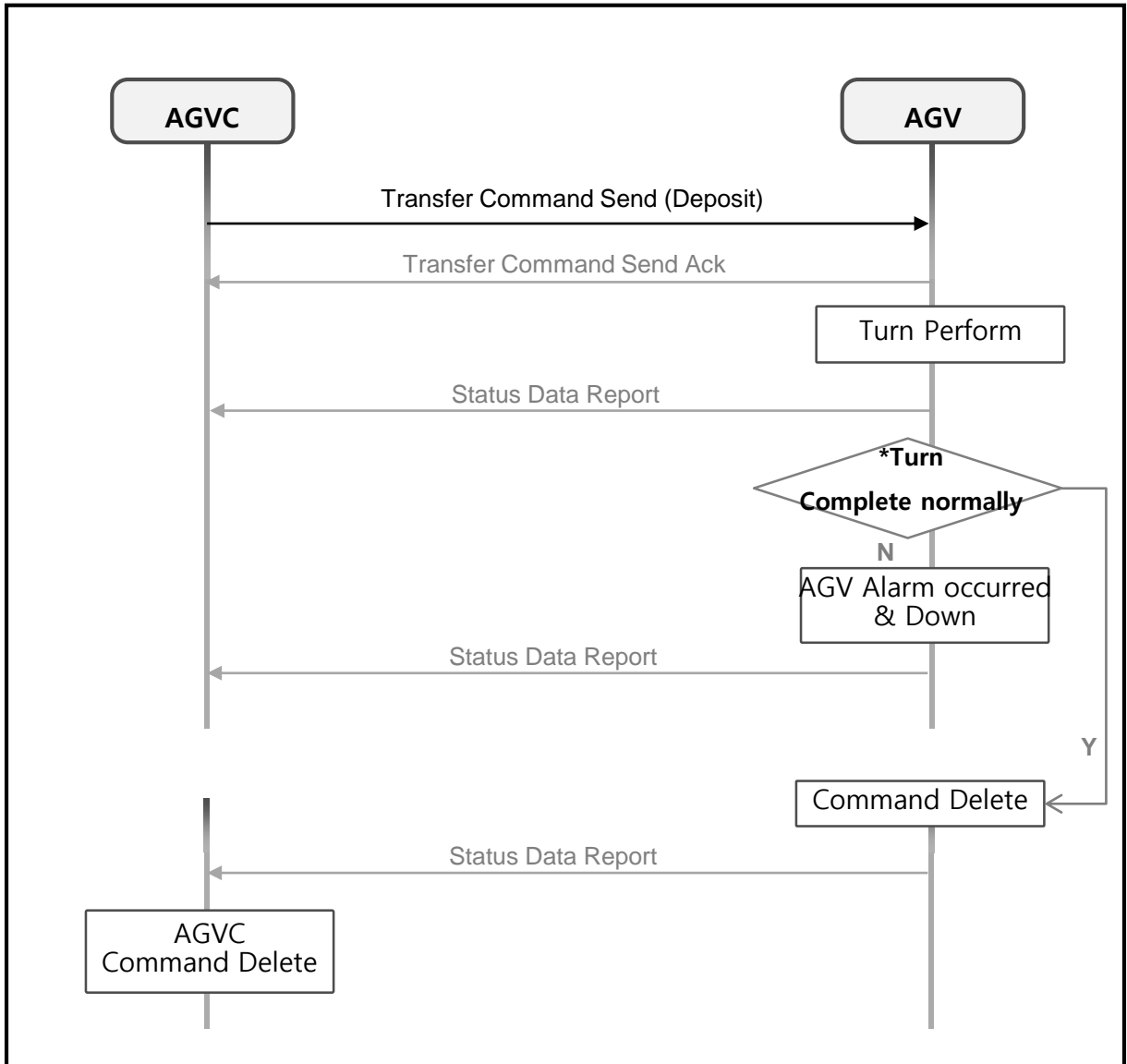
- 1) AGVC plans route for AGV automatically as many Nodes (MAX: 15) as set to explore Collision avoidance & Bypass.
- 2) If AGV is stopped or sending Arriving Signal, transfer command about next stopover.
- 3) AGV moves as many Nodes as command, before arriving the last Node, at constant velocity area, AGV will send Arriving signal to AGVC.
- 4) If AGV received identical command & identical destination from AGVC, cancel Command Message and keep performing command that existing.
- 5) If a command that will be transfer to AGV keep existing, repeat Sequence above.

4. Scenarios

4.3 Transfer Command Send (Turn)

- Turn Command transfer's Scenario to AGV

[Sequence]



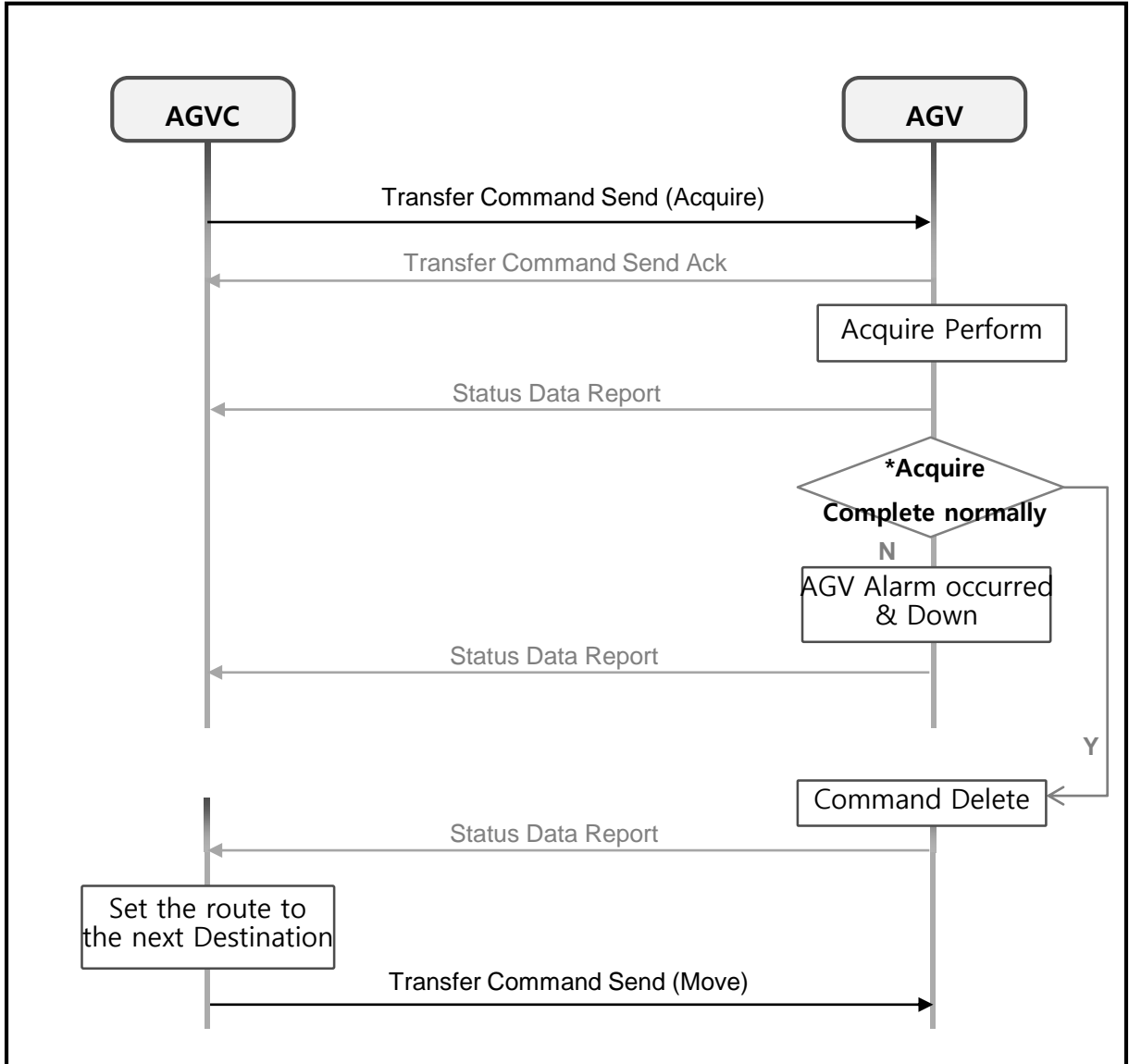
- 1) If direction (East.W.S.N) is changed while AGG is moving, Spin Turn will perform by itself.
- 2) When AGV has to move in special direction to enter into special area, AGVC will make AGV move to Spin Turn Node, and then transfer Turn Command to AGV that correspond to the direction.
- 3) When AGV enter into the next Node from Spin Turn Node, it will determine on performing Spin Turn or not through AGV's direction (East.W.S.N)

4. Scenarios

4.4 Transfer Command Send (Acquire)

- Acquire Command transfer's Scenario to Vehicle

[Sequence]



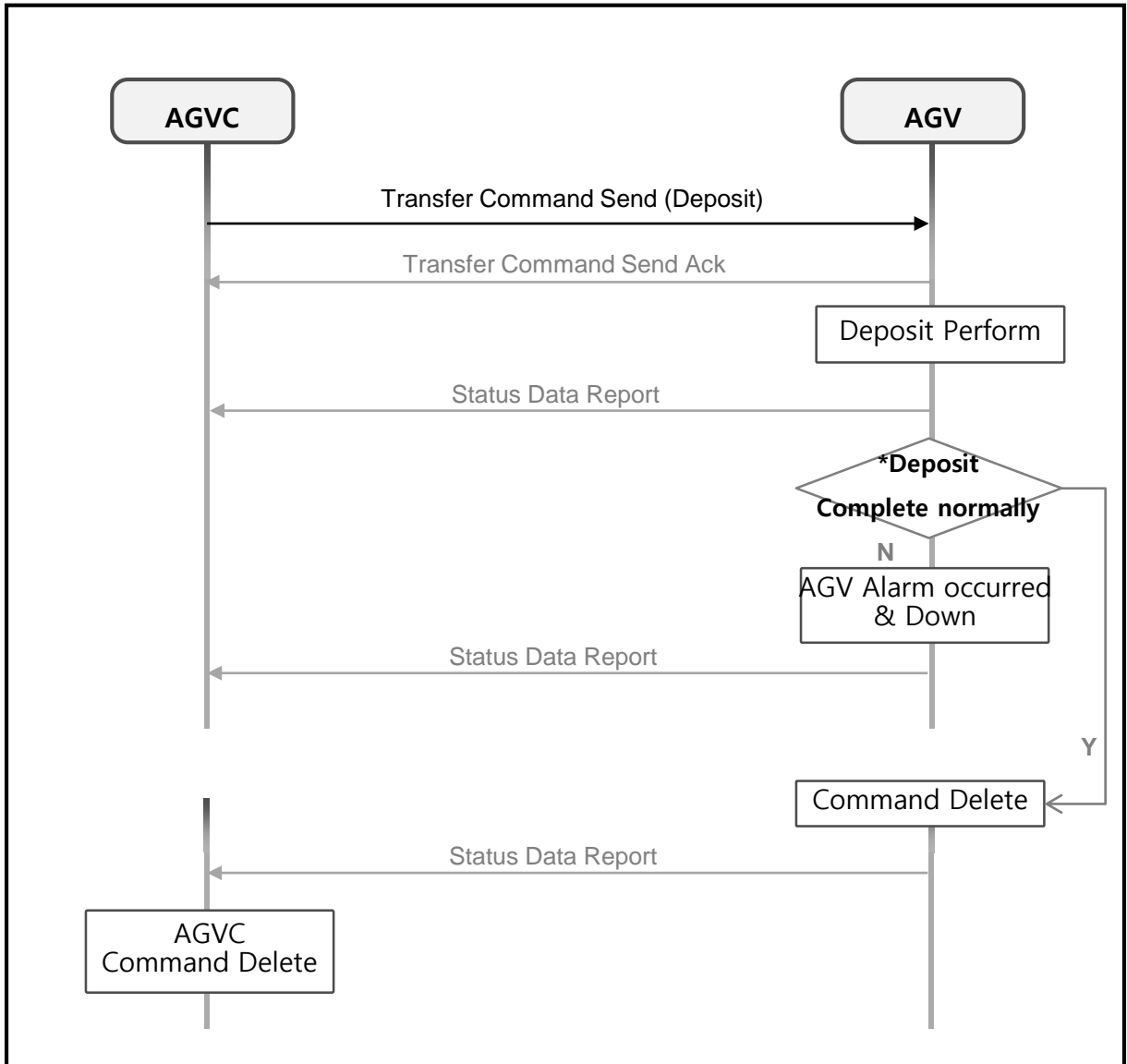
- 1) Acquire normal complete conditions is based on H/W spec.
- 2) When AGV is in Acquire, If Alarm occurred, keep Command while Down. After that, performing method the command comes from AGVC is based on high Host spec.
- 3) When Alarm is released, if the command still remains, repeat Acquire.
- 4) When command performing is not match with Goods status, Miss Match Alarm occurred at AGV.

4. Scenarios

4.5 Transfer Command Send (Deposit)

- Deposit Command transfer's Scenario to Vehicle

[Sequence]



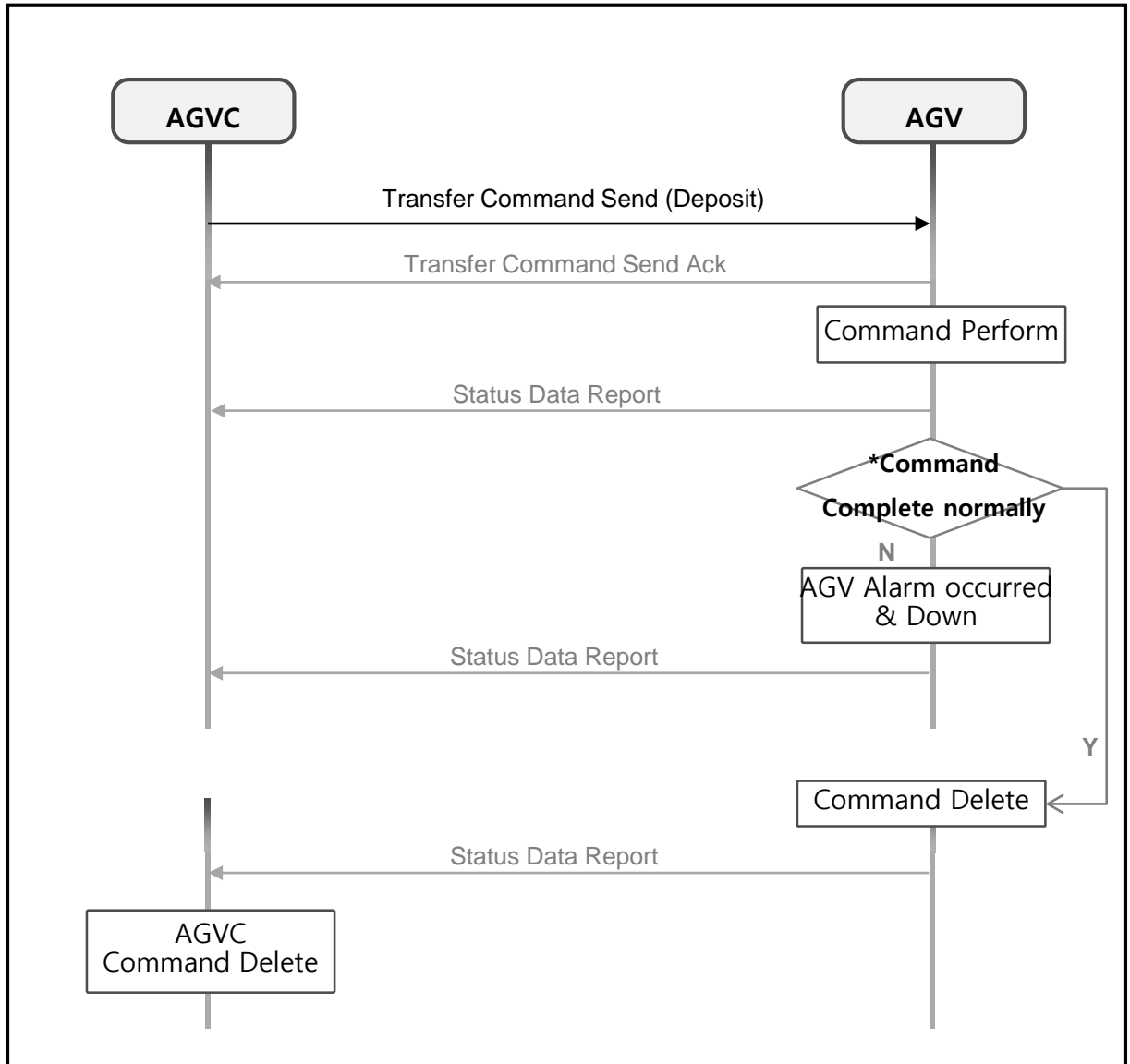
- 1) Deposit normal complete conditions is based on H/W spec.
- 2) When AGV is in Deposit, If Alarm occurred, keep Command while Down. After that, performing method the command comes from AGVC is based on high Host spec.
- 3) When Alarm is released, if the command still remains, repeat Deposit.
- 4) When command performing is not match with Goods status, Miss Match Alarm occurred at AGV.

4. Scenarios

4.6 Transfer Command Send (기타)

- Stop/Pause/Resume/Abort/Cancel Command transfer's Scenario to Vehicle

[Sequence]



1) When Alarm is released, if the command still remains, repeat Command.

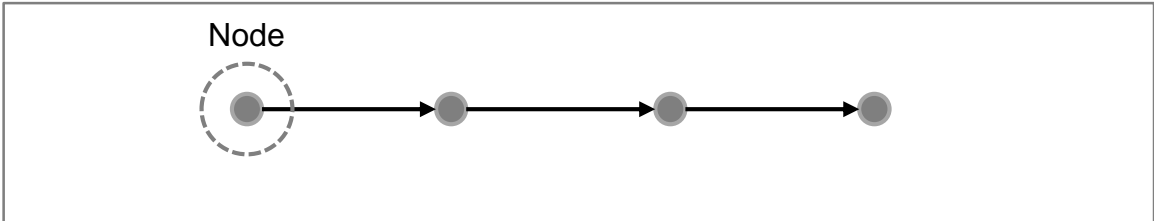
5. Layout

5.1 Layout Design

- AGV Layout is made up of Node and Link. This Layout is managed by identical version with AGV and AGVC

5.1.1 Node

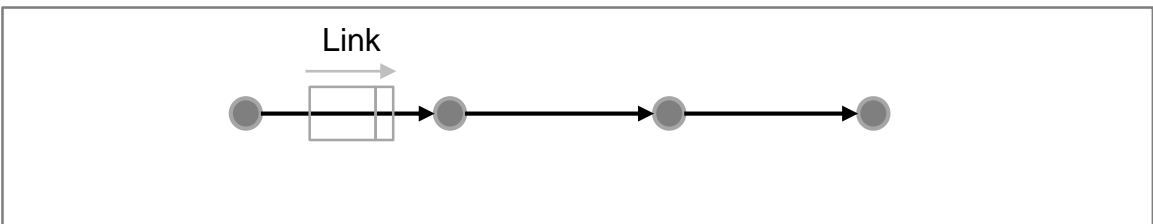
- The target point that AGV has to be moving to



- 1) AGV can only stopped at Node.
- 2) AGVC will count the number of target Node that AGV has to be moving to and transfer to AGV. (Max : 15)
- 3) AGV stops by command receiving Nodes from AGVC.
- 4) While AGV is stopping by Node, if the Current Node and the Next Node is not contiguous, derailment error occurred.

5.1.2 Link

- AGV moving route



- 1) Link has moving direction. AGV is divided by Forward direction & Backward direction.
- 2) When Link type is Any, AGV can moves Forward & Backward also.
- 3) While AGV is moving, If Link Type is changed into Forward or Backward from Any, AGVC will transfer Turn Command that correspond to the direction.
- 4) When AGV enter into the Next Link from the Current Link. If it moves in another direction (F/B) although the direction (East.W.N.S) was identical, Derailment Error occurred. (Error Checked for moving direction in Layout Editor so this is rarely case)

5. Layout

5.2 Layout Format

5.2.1 Node

- All of Layout information is Integer data type and it will be shared by Excel File
- Version information is integer data type and it will be saved at the first tab

Item	ID	X	Y	TYPE	BLK	DESC
------	----	---	---	------	-----	------

- 1) **ID** : Link ID
- 2) **X** : X-Coordinate of Node
- 3) **Y** : Y-Coordinate of Node
- 4) **TYPE** : Type information of Node
 - 0 : Normal
 - 1 : Un/uploading Node
 - 2 : Charging Node
 - 3 : Park Node
- 5) **BLK** : Node Block information (AGV is no need to refer/ AGV không cần tham khảo)
- 6) **DESC** : Additional information

- Map Format Example



Map

5. Layout

5.2 Layout Format

5.2.2 Link

- All of Map information is Integer data type and it will be shared by Excel File
- Version information is integer data type and it will be saved at the first tab

Item	ID	NUM	FROM	TO	FB	DIR	E-DIR	V_DIR	TURN	TYPE	DIST	V	TIME	BLK	WEIGHT	DESC
------	----	-----	------	----	----	-----	-------	-------	------	------	------	---	------	-----	--------	------

- 1) **ID** : Link ID
- 2) **NUM** : A combination of "FROM NODE ID" and "TO NODE ID"
- 3) **FROM** : Start Node ID
- 4) **TO** : End Node ID
- 5) **FB** : Forward/Backward direction information
 - 0 : Forward
 - 1 : Backward
 - 2 : Any (Can move Forward / Backward)
- 6) **DIR** : Link Direction (START)
 - 0 : East (Đông)
 - 1 : West (Tây)
 - 2 : South (Nam)
 - 3 : North (Bắc)
 - 4 : None
- 7) **E_DIR** : Link Direction (END)
 - 0 : East (Đông)
 - 1 : West (Tây)
 - 2 : South (Nam)
 - 3 : North (Bắc)
 - 4 : None
- 8) **V_DIR** : Vehicle Direction on link
 - 0 : East (Đông)
 - 1 : West (Tây)
 - 2 : South (Nam)
 - 3 : North (Bắc)
 - 4 : None

→ Next Page

5. Layout

5.2 Layout Format

- 9) **TURN** : Turn direction information (Link's target point direction information except straight-line)
 - 0 : NONE
 - 1 : LEFT
 - 2 : RIGHT
- 10) **TYPE** : Link Type
 - 0 : Straight
 - 1 : Curve
 - 2 : Crab-wise
 - 3 : Side-Way (Diff)
 - 4 : Direct Side-Way (Diff(S))
 - 5 : Straight To Side-Way
 - 6 : Side-Way To Straight
- 11) **DIST** : Link distance (mm)
- 12) **V** : Link speed (%)
- 13) **TIME** : Travel Time (ms)
- 14) **BLK** : Link Block information (AGV is no need to refer / AGV không cần tham khảo)
- 15) **WEIGHT** : arbitrary additional time weight to search shortest path
(AGV is no need to refer / AGV không cần tham khảo)
- 16) **DESC** : Additional information

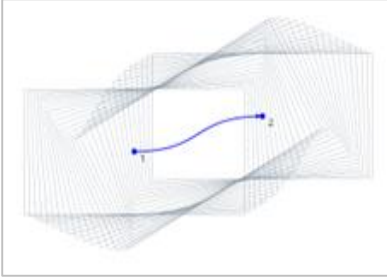
→ Next Page

5. Layout

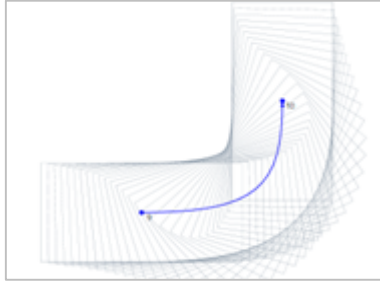
5.2 Layout Format

※ Link Type Example

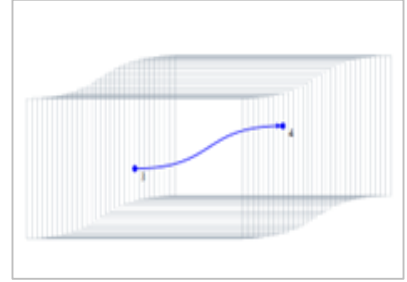
0 : Straight



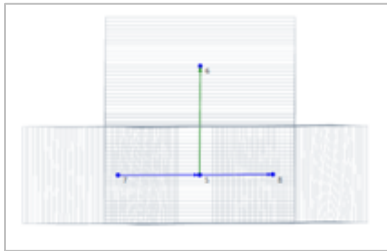
1 : Curve



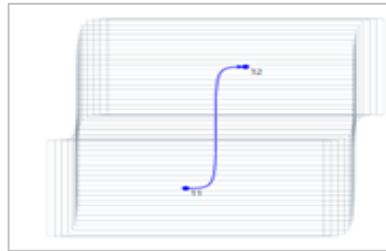
2 : Crab-Wise



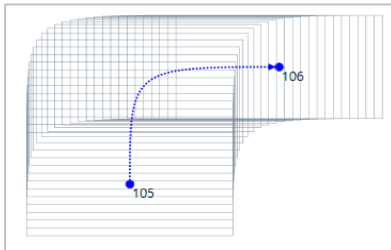
3 : Side-Way (Diff)



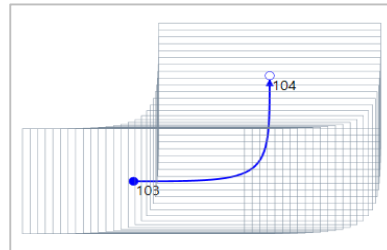
4 : Direct Side-Way (Diff(S))



5 : Side-Way To Straight



6 : Straight To Side-Way



5. Layout

5.2 Layout Format

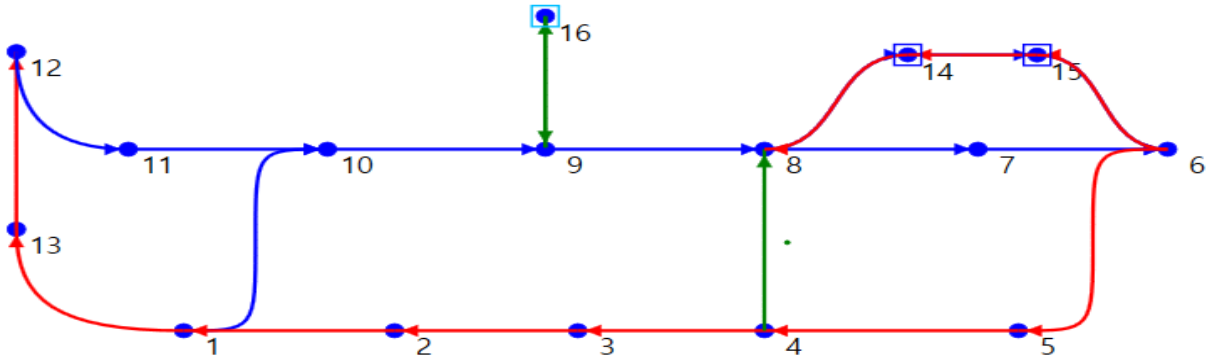
5.2.3 LockZone (AGV is no need to consult / AGV không cần tham khảo mục này)

- All of Map information is Integer data type and it will be shared by Excel File
- Version information is integer data type and it will be saved at the first tab

Item	ID	MAX_CNT	NODES	DESC
------	----	---------	-------	------

- 1) **ID** : LockZone ID
- 2) **MAX_CNT** : Number of Vehicle limited at LockZone area
- 3) **NODES** : Node list that included in LockZone
- 4) **DESC** : Additional information

Appendix. MAP EXAMPLE (1/2)



NODE

ID	X	Y	TYPE	BLK	DTYPE	DESC
1	24393	81346	0	38;54;56	0	
2	25471	81346	0	38;52;53;54	0	
3	26408	81346	0	51;52;53;54;55	0	
4	27362	81346	0	51;52;53;55	0	
5	28660	81346	0	50;51	0	
6	29423	82546	0	46;47;48;49;50;61;62	0	
7	28453	82546	0	45;46;47;48;49;50;61;62;63	0	
8	27362	82546	0	44;45;46;48;55;61;63	0	
9	26242	82546	0	41;42;43;44	0	
10	25128	82546	0	38;41;58;60	0	
11	24110	82546	0	38;41;56;58;59;60	0	
12	23538	83191	0	58;59;60	0	
13	23538	82017	0	38;54;56;58;59;60	0	
14	28095	83170	1	44;45;46;47;48;49;55;61;62;63	0	
15	28756	83169	1	45;46;47;48;49;50;61;62;63	0	
16	26242	83426	2	42;43	0	

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Appendix. Communication LOG EXAMPLE

1.Time Data Set

```
[ECAGV106V001_Network] [SEND] 84 50 48 50 49 48 50 50 51 49 49 51 48 50
50 69
[ECAGV106V001_Network] [RECV] [84 69]
```

2.Status Data Request / Report

```
[ECAGV106V001_Network] [SEND] 83 1 69
[ECAGV106V001_Network] [RECV] [83 1 173 0 0 0 0 0 0 191 18 79 0 0 4 8 0 0
0 0 0 0 0 173 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 69]
```

3. Transfer Command Send

1)Move

```
[ECAGV106V001_Network] [SEND] 67 1 2 0 0 0 49 49 49 49 49 0 0 0 0 0 3 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 69
[ECAGV106V001_Network] [RECV] [67 1 69]
```

2)Turn

```
[ECAGV106V001_Network] [SEND] 67 1 32 0 0 10 0 0 0 0 0 0 0 0 0 0 35 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 69
[ECAGV106V001_Network] [RECV] [67 1 69]
```

3)Acquire

```
[ECAGV106V001_Network] [SEND] 67 1 4 0 0 0 49 49 49 49 49 0 0 0 0 0 17 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 69
[ECAGV106V001_Network] [RECV] [67 1 69]
```

4)Deposit

```
[ECAGV106V001_Network] [SEND] 67 1 8 0 0 0 49 49 49 49 49 0 0 0 0 0 53 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 69
[ECAGV106V001_Network] [RECV] [67 1 69]
```