

0 7 4 5 ; _ 0 _ 2 5 4 5 = 8 5 _ 8 _ > 1 7 > @ - 1 (1)

0 B 0 : 1 8 . 1 1 . 2 0 2 5

0:) "

@>5:B: ><?;5:A=0O A8AB5<0 02B><0B870F88 A:;040
>:C<5=B: 0745; 0 - 2545=85 8 >1I89 >17>@
0B0: 16 =>O1@O 2025
5@A8O: 1.1
!B0BCA: #B25@645= : @50;870F88

! 0

1. 07=0G5=85 A8AB5<K
2. @E8B5:BC@0 @5H5=8O
3. -B0?K 2=54@5=8O (>17>@)
4. 0@80=BK <0AHB018@>20=8O
5. 5B>4>;>38O F5=>>1@07>20=8O
6. ;NG52K5 ?>:070B5;8 MDD5:B82=>AB8

1. ' !!" +

1.1 1I55 >?8A0=85

><?;5:A=0O A8AB5<0 02B><0B870F88 A:;040 ?@54AB02;O5B A>1
@5H5=85 2KAH53> C@>2=O, >1J548=ONI55 ?5@54>2K5 B5E=>;>38
8A:CAAB25==>3> 8=B5;;5:B0, 02B><0B878@>20==>3> E@0=5=8O
845=B8D8:0F88 (UHF RFID) 4;O A>740=8O ?>;=>ABLN 02B><0B87
A:;04A:>3> :><?;5:A0 =>2>3> ?>:>;5=8O.

!8AB5<0 @5H05B A;54CNI85 187=5A-7040G8:

' 0:A8<870F8O 8A?>;L7>20=8O A:;04A:8E ?>;I0459 - C25;8G5=85
E@0=5=8O 2 4-5 @07
' #A:>@5=85 >1@01>B:8 3@C7>2 - A>:@0I5=85 2@5<5=8 :><?;5:B
@070
' !=865=85 >?5@0F8>==KE 70B@0B - M:>=><8O 4> 70% =0 ?5@A>
' >2KH5=85 B>G=>AB8 CG5B0 - B>G=>ABL 99.9% vs 95-98% ?@8
' 01>B0 2 @568<5 24/7 - =5?@5@K2=0O >1@01>B:0 157 ?5@5@K2
' 0AHB018@C5<>ABL - 381:>5 @0AH8@5=85 ?> <5@5 @>AB0 187
' @>A;568205<>ABL B>20@>2 - ?>;=K9 :>=B@>;L ?5@5<5I5=89 2
2@5<5=8

1.2 &5;52K5 >B@0A;8 ?@8<5=5=8O

B@0A;L	! ?5F8D8:0 ?@8<5=5=8	;NG52K5 ?@58<CI5AB20
E-commerce (-;5:B@>==0 (70:07>2 (BKAOG8 ?>7 :><<5@F8O) 45=L)	KA>:0O A:>@>ABL > (BKAOG8 ?>7 45=L)	KAB@0O :><?;5:B0F8O, B>G=>ABL A1>@:8 99.9%
@>872>4AB2 A:;04K	WIP (Work In Progress), :><?>=5=B=K5 A:;04K	">G=K9 CG5B :><?>=5=B>2, 70I8B0 >B 45D8F8B0

B@0A;L	! ?5F8D8:0 ?@8<5=5=8	;NG52K5 ?@58<CI5AB20
\$0@<0F52B8:	!B@>385 B@51>20=8C A@>:8 3>4=>AB8	FIFO/FEFO 02B><0B8G5A:8, B5<?5@0BC@=K9 :>=B@>;L
2B>70?G0AB :><?;5:BCNI8	>;LH0O =><5=:;0BC@ SKU)	KAB@K9 ?>8A:, <8=8<870F8 >H81>: ?>41>@0
8AB@81LNB F5=B@K	@>AA-4>:8=3, <C;LB8:0=0;L=>ABL	?B8<870F8O <0@H@CB>2, <8=8<870F8O 2@5<5=8 E@0=5=8O
@E82=>5 E@0=5=85	>:C<5=BK, <5480-0@	KA>:0O ?;>B=>ABL, 1KAB@ 4>ABC? : 0@E820<
@>4C:BK ?8 (dry storage)	!::;04K ACE8E ?@>4C: :>=A5@2>2	>=B@>;L A@>:>2, @>B0F8O ?> FIFO

1.3 5H05<K5 ?@>1;5<K B@048F8>==KE A::;04>2

@>1;5<0 1: 87:0O ?;>B=>ABL E@0=5=8O

- "@048F8>==K9 A::;04: 2-3 :>=B59=5@0 =0 1 <² ?;>I048
- 0H5 @5H5=85: 14 :>=B59=5@>2 =0 1 <² (25@B8:0;L=>5 E@0=5
- -DD5:B: -:>=><8O 70% ?;>I048 8;8 C25;8G5=85 5<:>AB8 2 4-5

@>1;5<0 2: 54;5==0O >1@01>B:0 70:07>2

- "@048F8>==K9 A::;04: ?5@0B>@ ?@>E>48B 10-15 :< 2 A<5=C,
70:07>2
- 0H5 @5H5=85: UGV @>1>BK 4>AB02;ONB B>20@K : >?5@0B>
A<5=C
- -DD5:B: @>872>48B5;L=>ABL 2 3× @07 2KH5

@>1;5<0 3: KA>:89 C@>25=L >H81>:

- "@048F8>==K9 A::;04: 2-5% >H81>: ?@8 @CG=>9 :><?;5:B0F88
- 0H5 @5H5=85: UHF RFID 02B><0B8G5A:0O 25@8D8:0F8O, <0.0
- -DD5:B: !=865=85 1@0:0, 2>72@0B>2, @5::;0<0F89

@>1;5<0 4: 028A8<>ABL >B G5;>25G5A:>3> D0:B>@0

- "@048F8>==K9 A::;04: "5:CG5ABL ?5@A>=0;0, 1>;L=8G=K5, >B
- 0H5 @5H5=85: >1>BK @01>B0NB 24/7 157 ?5@5@K2>2
- -DD5:B: !B018;L=0O ?@>872>48B5;L=>ABL, =57028A8<>ABL >

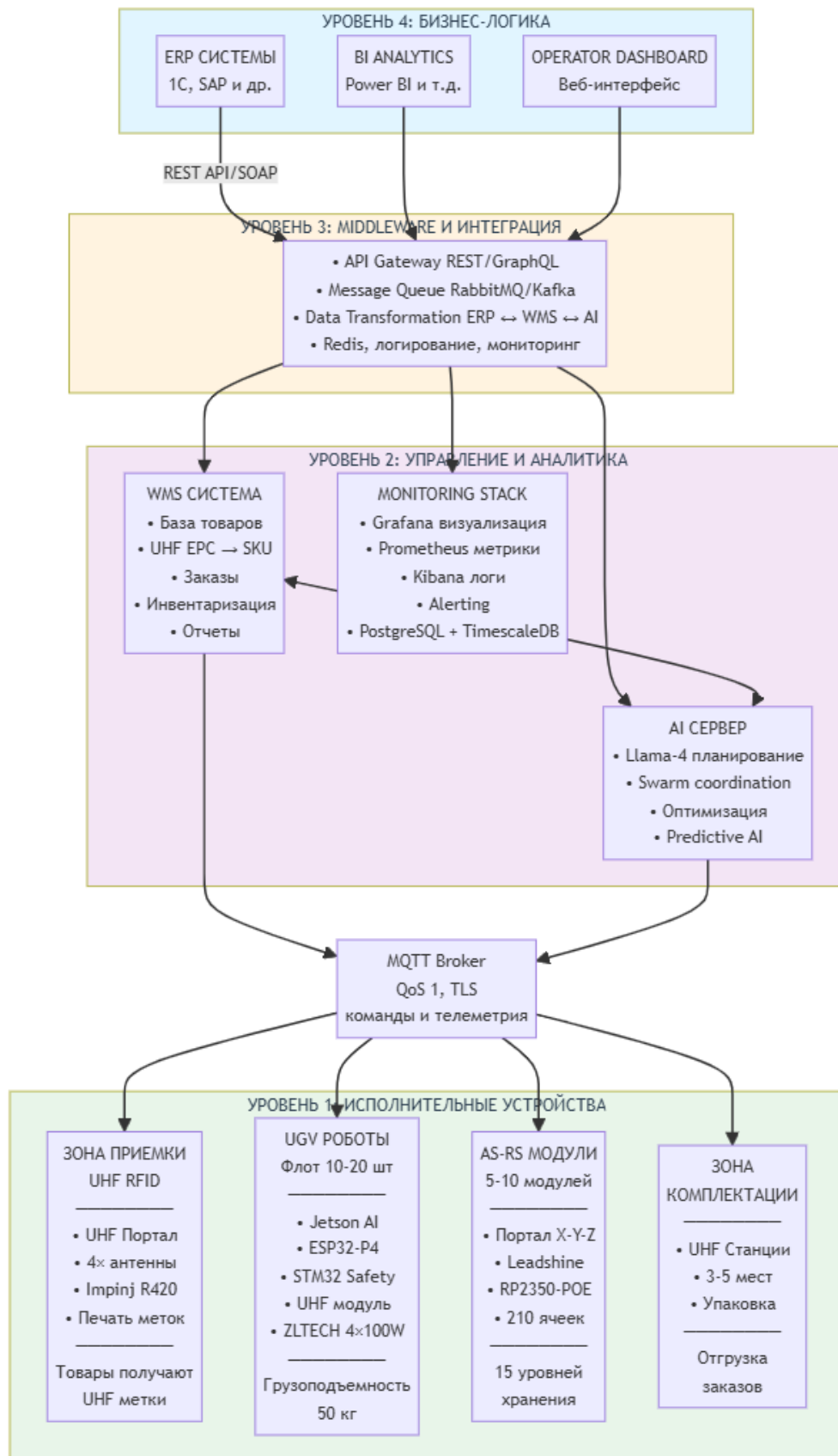
@>1;5<0 5: BACBAB285 ?@>A;568205<>AB8

- "@048F8>==K9 A::;04: ">20@ 345-B> =0 A::;045", 8=25=B0@870
- 0H5 @5H5=85: UHF RFID >BA;56820=85 2 @50;L=>< 2@5<5=8,
30-60 <8=CB

• -DD5:B: >;=0O ?@>7@0G=>ABL, 70I8B0 >B ?>B5@L

2. % " "# (/

2.1 1I0O AE5<0 A8AB5<K



2.2 ;NG52K5 ?>4A8AB5<K

07=0G5=85: 2B><0B8G5A:0O 845=B8D8:0F8O B>20@>2 8 :>=B59:
:>=B0:B0

><?>=5=BK:

- UHF <5B:8 =0 B>20@0E (?0AA82=K5, 865-868 F)
- UHF <5B:8 =0 :>=B59=5@0E (CA8;5==K5 IP67)
- >@B0; ?@85<:8 A 4 0=B5==0<8 (<0AA>2>5 AG8BK20=85 4> 20
- UHF <>4C;8 =0 UGV @>1>B0E (:>=B@>;L 703@C7:8)
- !B0=F88 25@8D8:0F88 2 7>=5 :><?;5:B0F88
- @8=B5@ RFID <5B>: (Zebra ZT411)

>:@KB85: 5AL A::04 - >B ?@85<:8 4> >B3@C7:8

07=0G5=85: 2B>=><=0O B@0=A?>@B8@>2:0 :>=B59=5@>2 <564C

"5E=8G5A:85 E0@0:B5@8AB8:8:

- @C7>?>4J5<=>ABL: 50 :3 (157>?0A=0O), 68 :3 (01A>;NB=K9 <
- 010@8BK: 700×500×200 <<
- !:>@>ABL: 4.5 :</G (@01>G0O), 6.5 :</G (<0:A8<0;L=0O)
- !E5<0 42865=8O: 4×4 (2A5 :>;5A0 0:B82=K5)
- 02830F8O: ArUco <5B:8 + AI (B>G=>ABL ±0.5 A<)
- 2B>=><=>ABL: 6-8 G0A>2 0:B82=>9 @01>BK
- @82>4K: ZL TECH 4× 100W <>B>@-:>;5A0
- AI: Jetson Orin Nano (20 TOPS)
- 57>?0A=>ABL: 5-C@>2=520O A8AB5<0 70I8BK

\$;>B: 10-20 @>1>B>2 (<0AHB018@C5BAO)

07=0G5=85: 5@B8:0;L=>5 E@0=5=85 :>=B59=5@>2 8 02B><0B878

"5E=8G5A:85 E0@0:B5@8AB8:8 <>4C;O:

- 010@8BK: 6000×2500×6020 << (×(×)
- ;>I04L: 15 <²
- <:>ABL: 210 :>=B59=5@>2 (2 AB5;;060 × 105 OG55:)
- #@>2=8: 15 (2KA>B0 O@CA0 ~390 <<)
- @>872>48B5;L=>ABL: 90-120 >?5@0F89/G0A
- ">G=>ABL: ±0.5 << (?> 2A5< >AO< X, Y, Z)
- >@B0;; 3 >A8 (X - 6<, Y - 6<, Z - 0.8<)
- !5@2>42830B5;8: Leadshine 750 B (X), 1000 B (Y), 400 B (Z)

- >=B@>;5@: RP2350-POE (Ethernet, Modbus RTU)

0AHB018@>20=85: 5-10 <>4C;59 (1050-2100 :>=B59=5@>2)

07=0G5=85: >>@48=0F8O 2A5E ?>4A8AB5<, ?;0=8@>20=85, >?B8

\$C=:F88:

- ;0=8@>20=85 B@05:B>@89 UGV (871530=85 :>;8789)
- Swarm coordination (C?@02;5=85 D;>B>< @>1>B>2)
- 0A?@545;5=85 7040G AS-RS (10;0=A8@>2:0 =03@C7:8)
- ?B8<870F8O @07<5I5=8O B>20@>2 (3>@OG85 7>=K)
- @>3=>78@>20=85 A?@>A0 (predictive analytics)
- >=8B>@8=3 A>AB>O=8O >1>@C4>20=8O
- \$>@<8@>20=85 >BG5B>2 8 0=0;8B8:8

>=D83C@0F8O:

- CPU: AMD EPYC / Intel Xeon (16-32 O4@0)
- GPU: NVIDIA A4000 8;8 0=0;>3 (AI 2KG8A;5=8O)
- RAM: 64-128 GB
- Storage: 2×2TB NVMe SSD (RAID 1)
- Network: 10 GbE, Wi-Fi 6E Access Point

07=0G5=85: #?@02;5=85 A:;04>< 8 8=B53@0F8O A 2=5H=8<8 A8A

><?>=5=BK:

- WMS (Warehouse Management System) - C?@02;5=85 A:;04><
- API Gateway - 548=0O B>G:0 2E>40 4;O 2=5H=8E A8AB5<
- Message Queue (RabbitMQ/Kafka) - >G5@54L 7040G
- Middleware - B@0=AD>@<0F8O 40==KE <564C ERP 8 AI
- 070 40==KE PostgreSQL + TimescaleDB
- >=8B>@8=3 Grafana + Prometheus

=B53@0F88:

- ERP A8AB5<K (1C, SAP, Oracle 8 4@.)
- BI 0=0;8B8:0 (Power BI, Tableau)
- "@0=A?>@B=K5 A8AB5<K (" !)

2.3 =D>@<0F8>==K5 ?>B>:8

>B>: 1: @85<:0 B>20@0

>AB02I8:! ERP (=0::04=0O)! WMS (7040G0 ?@85<:8)!
!' ?5@0B>@ (UHF ?>@B0; AG8BK205B <5B:8)! WMS (>1=>2;5=85)!'
!' AI !5@25@ (7040G0 @07<5I5=8O)! UGV (B@0=A?>@B8@>2:0)!
!' AS-RS (@07<5I5=85 2 OG59:C)! WMS (?>4B25@645=85)

>B>: 2: ><?:5:B0F8O 70:070

;85=B (70:07)! ERP! WMS (D>@<8@>20=85 7040G8)!
!' AI !5@25@ (>?B8<870F8O <0@H@CB0)! AS-RS (872;5G5=85 :>=B59=5@>2)!
!' UGV (B@0=A?>@B8@>2:0 : 7>=5 :><?:5:B0F88)!
!' ?5@0B>@ (>B1>@ B>20@>2, UHF 25@8D8:0F8O)! WMS (?>4B25@645=85)!
!' >=0 C?0:>2:8! B3@C7:0

>B>: 3: =25=B0@870F8O

WMS (7040G0 8=25=B0@870F88)! AI !5@25@ (<0@H@CB UGV)!
!' UGV (>1E>4 A::040 A UHF A:0=8@>20=85<)!
!' WMS (02B><0B8G5A:>5 A>?>AB02;5=85 EPC! SKU)!
!' BG5B > @0AE>645=8OE (30-60 <8=CB 2<5AB> 8-12 G0A>2)

3. -" + / ()

3.1 >A;54>20B5;L=>ABL 2=54@5=8O

!8AB5<0 2=54@O5BAO ?>MB0?=>, :064K9 MB0? 4>102;O5B DC=:F
8=B53@8@C5BAO A ?@54K4CI8<8:

- " 1	- " 2	- " 3	- " 4	- " 5
% %¼	% %¼	% %¼	% %¼	% %¼
% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %
% UHF % % %	% % % % % % % % % %	% UGV %	% AS-RS % %	%
% RFID % % % % % %	% % % % % % % % % %	" + % % % % % % % %	#	% % % % % %
% . % % (>@B0;) %	% (A UHF) %	% (!B5;;068)%	% (#?0:>2:0)%	%
% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %	% % % % % % % % % %
2-3 =54.	4-6 =54.	6-8 =54.	8-12 =54.	4-6 =54.

+ -" 6: AI !5@25@ (?0@0;;5;L=> A -B0?>< 3-4, 4-6 =545;L)

+ -" 7: 8 8=B53@0F8O (?0@0;;5;L=> A -B0?>< 2-5, 8-12 =545;L)

3.2 @0B:>5 >?8A0=85 MB0?>2

- " 1: =54@5=85 UHF RFID <0@:8@>2:8 (2-3 =545;8)

- 0:C?:0 UHF <5B>: (?0AA82=K5 =0 B>20@K, CA8;5==K5 =0 :>=
- #AB0=>2:0 ?@8=B5@0 RFID <5B>: (Zebra ZT411)
- 07@01>B:0 AE5<K :>48@>20=8O EPC
- 1CG5=85 ?5@A>=0;0 <0@:8@>2:5 B>20@>2
- 57C;LB0B: A5 B>20@K 8 :>=B59=5@K ?>;CG0NB C=8:0;L=K5

- " 2: >=0 ?@85<:8 A> AG8BK20=85< UHF (4-6 =545;L)

- 73>B>2;5=85 @0<K ?>@B0;0 ?@85<:8 (3000×2500×2000 <<)
- #AB0=>2:0 UHF AG8BK20B5;O Impinj Speedway R420

- >=B06 4 0=B5== (<0AA>2>5 AG8BK20=85 4> 200 <5B>:/A5:)
 - 0AB@>9:0 ?@85<:8 (RFID Middleware + WMS)
 - =B53@0F8O A ERP
 - 57C;LB0B: 2B><0B8G5A:0O ?@85<:0 B>20@>2 70 2-3 <8=CBK 2@CG=CN)
- " 3: UHF @>1>BK (UGV A A8AB5<>9 AG8BK20=8O) (6-8 =545;L
- !1>@:0 UGV @>1>B>2 (1, 10 8;8 20 548=8F ?> 20@80=BC)
 - #AB0=>2:0 UHF <>4C;59 =0 :064K9 @>1>B (ThingMagic M6e Na
 - 07<5B:0 A:;040 ArUco <5B:0<8 (=02830F8O)
 - 0AB@>9:0 AI ?;0=8@>20=8O B@05:B>@89
 - "5AB8@>20=85 D;>B0
 - 57C;LB0B: 2B>=><=0O B@0=A?>@B8@>2:0 :>=B59=5@>2, :>=G5@57 UHF
- " 4: 2B><0B878@>20==K9 <>4C;L=K9 A:;04 AS-RS (8-12 =545;L
- 73>B>2;5=85 AB5;;0659 8 ?>@B0;>2 (5-10 <>4C;59 ?> 20@80=
 - >=B06 =0?@02;ONI8E, A5@2>42830B5;59, 70E20B>2
 - #AB0=>2:0 :>=B@>;;5@>2 RP2350-POE
 - 0AB@>9:0 A8AB5<K C?@02;5=8O (Modbus RTU)
 - =B53@0F8O A AI A5@25@><
 - CA:>=0;04:0 (:0;81@>2:0, B5AB8@>20=85)
 - 57C;LB0B: 5@B8:0;L=>5 E@0=5=85 1050-2100 :>=B59=5@>2, ?@>872>48B5;L=>ABL 450-1200 >?5@0F89/G0A
- " 5: >=0 :><?;5:B>20=8O 8 >B3@C7:0 (4-6 =545;L)
- 1>@C4>20=85 @01>G8E <5AB :><?;5:B0F88 (3-5 <5AB)
 - #AB0=>2:0 UHF AB0=F89 25@8D8:0F88
 - 0AB@>9:0 :>=2595@=>9 A8AB5<K (>?F8>=0;L=>)
 - 1CAB@>9AB2> 7>=K C?0:>2:8
 - =B53@0F8O A WMS 4;O D>@<8@>20=8O 70:07>2
 - 57C;LB0B: #A:>@5=85 :><?;5:B0F88 2 3× @070, B>G=>ABL 99
- " 6: AI !5@25@ 8 A8AB5<0 C?@02;5=8O (4-6 =545;L, ?0@0;;5;L
- 0:C?:0 8 A1>@:0 A5@25@0 (CPU, GPU, RAM, Storage)
 - #AB0=>2:0 (MQTT, PostgreSQL, Llama-4, Grafana)
 - 07@01>B:0 0;3>@8B<>2 >?B8<870F88

- 0AB@>9:0 <>=8B>@8=30 8 0;5@B8=30
- 57C;LB0B: &5=B@0;87>20==>5 C?@02;5=85 2A5<8 ?>4A8AB5<
- " 7: 8 8=B53@0F8O (8-12 =545;L, ?0@0;;5;L=>)
- 07@01>B:0 WMS <>4C;59 (?@85<:0, @07<5I5=85, :><?;5:B0F8O)
- !>740=85 API Gateway 8 Middleware
- =B53@0F8O A ERP (1C, SAP)
- 07@01>B:0 Dashboard 4;O >?5@0B>@>2
- "5AB8@>20=85 end-to-end AF5=0@852
- 57C;LB0B: >;=0O 02B><0B870F8O A;;04A:8E ?@>F5AA>2

3.3 1I89 A@>: 2=54@5=8O

8;>B=K9 ?@>5:B (<8=8<0;L=0O :>=D83C@0F8O): 16-20 =545;L (~0AHB018@>20=85-1 (A@54=OO :>=D83C@0F8O): 20-24 =545;8 (~0AHB018@>20=85-2 (?>;=0O :>=D83C@0F8O): 24-28 =545;L (~6-7
!@>:8 C:070=K A CG5B>< ?0@0;;5;L=>3> 2K?>;=5=8O MB0?>2 6 8
4. " + !(" /

4.1 0@80=B 1: " + " (8=8<0;L=0O :>=D83C@0F8O)

07=0G5=85: "5AB8@>20=85 B5E=>;>388, >1CG5=85 ?5@A>=0;0, >
!>AB02 A8AB5<K:

- UHF RFID <0@:8@>2:0: =0G0;L=K9 70?0A <5B>: (10,000 B>20@ :>=B59=5@=KE)
- >=0 ?@85<:8: 1 UHF ?>@B0; A 4 0=B5==0<8
- UGV @>1>BK: 1 548=8F0 (4;O B5AB8@>20=8O ;>38AB8:8)
- AS-RS <>4C;8: 1 <>4C;L (210 :>=B59=5@>2, 15 <^)
- >=0 :><?;5:B0F88: 3 @01>G8E <5AB0 A UHF 25@8D8:0F859
- AI !5@25@: 1 548=8F0 (107>20O :>=D83C@0F8O)
- : 107>2K5 <>4C;8 WMS + 8=B53@0F8O A 1C

@>872>48B5;L=>ABL:

- <:>ABL E@0=5=8O: 210 :>=B59=5@>2 (~1050 B>20@=KE ?>78I HB/:>=B59=5@)
- 1@01>B:0: 90-120 >?5@0F89 AS-RS/G0A
- ><?;5:B0F8O: 30-40 70:07>2/A<5=C (A 1 UGV)

@ 8<5=5=85:

- 51>;LH85 A::04K (4> 2000 SKU)
- "5AB>2K9 70?CA: ?5@54 <0AHB018@>20=85<
- !B0@B0?K, <0;K9 187=5A

!B>8<>ABL ?8;>B0: 07>20O AB>8<>ABL + 30% @575@2=K9 D>=4

4.2 0@80=B 2: !(" -1 (!@54=OO :>=D83C@0F8O)

07=0G5=85: >;=>F5==K9 02B><0B878@>20==K9 A::04 4;O A@54=

!>AB02 A8AB5<K:

- UHF RFID <0@:8@>2:0: 3>4>2>9 70?0A <5B>: (100,000 B>20@=>=B59=5@=KE)
- >=0 ?@85<:8: 1 UHF ?>@B0; (2>7<>6=>ABL @0AH8@5=8O 4>)
- UGV @>1>BK: 10 548=8F (?>;=>F5==K9 D;>B)
- AS-RS <>4C;8: 5 <>4C;59 (1050 :>=B59=5@>2, 75 <²)
- >=0 :><?;5:B0F88: 4 @01>G8E <5AB0 A UHF 25@8D8:0F859
- AI !5@25@: 1 548=8F0 (@0AH8@5==0O :>=D83C@0F8O A GPU)
- : ?>;=K9 WMS + 8=B53@0F8O A ERP (1C, SAP)

@>872>48B5;L=>ABL:

- <:>ABL E@0=5=8O: 1050 :>=B59=5@>2 (~5250 B>20@=KE ?>78 HB/:>=B59=5@)
- 1@01>B:0: 450-600 >?5@0F89 AS-RS/G0A (5 <>4C;59 ?0@0;;5;
- ><?;5:B0F8O: 150-200 70:07>2/A<5=C (A 10 UGV)

;>I04L: ~180-200 <² (7>=0 ?@85<:8 + AS-RS + :><?;5:B0F8O + B@

@ 8<5=5=85:

- !@54=85 A::04K (5,000-10,000 SKU)
- E-commerce (1000-2000 70:07>2/45=L)
- @>872>4AB25==K5 A::04K
- 8AB@81LNB>@A:85 F5=B@K

!B>8<>ABL: 07>20O AB>8<>ABL + 25-30% =5?@542845==K5 @0A

4.3 0@80=B 3: !(" -2 (>;=0O :>=D83C@0F8O)

07=0G5=85: @C?=K9 02B><0B878@>20==K9 A::04 4;O 1>;LH>3>

!>AB02 A8AB5<K:

- UHF RFID <0@:8@>2:0: 2× 3>4>2>9 70?0A <5B>: (200,000 B>20@=>=B59=5@=KE)

- $\geq 0 \text{ ?@85<:8: } 1-2 \text{ UHF ?>@B0;0 (?@0;;5;L=0O ?@85<:0)}$
- $\text{UGV @>1>BK: } 20 \text{ } 548=8\text{F (}<0:\text{A8}<0;\text{L=K9 D;}>\text{B)}$
- $\text{AS-RS } <>4\text{C;8: } 10 \text{ } <>4\text{C;59 (2100 :>=B59=5@>2, } 150 \text{ } <^2)$
- $\geq 0 \text{ :><?;5:B0F88: } 5 \text{ @01>G8E } <5\text{AB + :>=2595@=0O A8AB5}<0$
- $\text{AI !5@25@: } 1 \text{ } 548=8\text{F0 (}<0:\text{A8}<0;\text{L=0O :>=D83C@0F8O, multi-G}$
- $\text{: ?>;=K9 WMS + BI 0=0;8B8:0 + @0AH8@5==K5 8=B53@0F88}$

$\text{@>872>48B5;L=>ABL:}$

- $\text{<:>ABL E@0=5=8O: } 2100 \text{ :>=B59=5@>2 (}\sim 10,500 \text{ B}>20\text{@=KE ?>}$
 HB/:>=B59=5@)
- $\text{1@01>B:0: } 900-1200 \text{ } >?5@0\text{F89 AS-RS/G0A (10 } <>4\text{C;59 ?@0;;}$
- $\text{><?;5:B0F8O: } 300-400 \text{ } 70:07>2/\text{A}<5=\text{C (A } 20 \text{ UGV)}$

$\text{;>I04L: } \sim 350-400 \text{ } <^2 \text{ (7}>=0 \text{ ?@85<:8 + AS-RS + :><?;5:B0F8O + 1C}$

@8<5=5=85:

- $\text{@C?=K5 A:;04K (20,000+ SKU)}$
- $\text{E-commerce ;845@K (5000+ } 70:07>2/45=\text{L)}$
- $\text{@C?=K5 ?@>872>4AB25==K5 A:;04K}$
- $\text{538>=0;L=K5 48AB@81LNB>@A:85 F5=B@K}$

$\text{!B>8<>ABL: } 07>20\text{O AB}>8<>\text{ABL + } 25-30\% \text{ } =5?\text{@542845==K5 @0A}$

4.4 $\text{!@02=8B5;L=0O B01;8F0 } 20\text{@80=B}>2$

$0@0<5B@$	$8;>B$	$0AHB01-1$	$0AHB01-2$
UGV @>1>BK	1 HB	10 HB	20 HB
$\text{AS-RS } <>4\text{C;8}$	1 HB	5 HB	10 HB
$\text{<:>ABL (:>=B59=5@K)}$	210	1,050	2,100
$\text{<:>ABL (B}>20\text{@K, } \sim 5 \text{]}$	$\sim 1,000$	$\sim 5,000$	$\sim 10,000$
;>I04L A:;040	$50-60 \text{ } <^2$	$180-200 \text{ } <^2$	$350-400 \text{ } <^2$
@>872>48B5;L=>ABL	$90-120 \text{ } >?$	$450-600 \text{ } >?$	$900-1200 \text{ } >?/\text{G}$
$\text{0:07>2 } 2 \text{ A}<5=\text{C}$	30-40	150-200	300-400
$\text{01>G8E } <5\text{AB :><?;5:B}$	3	4	5
$\text{5@A>=0; (}>?5\text{@0B>@K}$	$2-3 \text{ G5;}$	$3-4 \text{ G5;}$	$4-6 \text{ G5;}$
$\text{!@>: } 2=54\text{@5=8O}$	$16-20 \text{ } =54$	$20-24 \text{ } =54$	$24-28 \text{ } =54$
$\text{575@2 } 2 \text{ AB}>8<>\text{AB8}$	+30%	+25-30%	+25-30%

4.5 0;L=59H55 <0AHB018@>20=85

!8AB5<0 ?@>5:B8@C5BAO A 2>7<>6=>ABLN =5>3@0=8G5==>3> <

>@87>=B0;L=>5 @0AH8@5=85 AS-RS:

- !BK:>2:0 <>4C;59 ?> 4;8=5 (6<!' 12<!' 18<!' ...)
- 1185 AB5;;068 <564C <>4C;O<8 (M:>=><8O <0B5@80;>2)

5@B8:0;L=>5 @0AH8@5=85 AS-RS:

- #25;8G5=85 2KA>BK AB5;;0659 (6<!' 9<!' 12< ?@8 4>AB0B>G=
- >?>;=8B5;L=K5 C@>2=8 E@0=5=8O (15!' 20!' 30 O@CA>2)

0AH8@5=85 D;>B0 UGV:

- >102;5=85 @>1>B>2 ?> <5@5 @>AB0 =03@C7:8 (20!' 30!' 50 5
- AI 02B><0B8G5A:8 040?B8@C5B ?;0=8@>20=85

5>3@0D8G5A:>5 @0A?@545;5=85:

- 5A:>;L:> 02B><0B878@>20==KE A:;04>2 2 @07=KE @538>=0E
- &5=B@0;87>20==>5 C?@02;5=85 G5@57 >1;0G=K9 AI !5@25@

5. " / & /

5.1 @8=F8?K D>@<8@>20=8O AB>8<>AB8

!B>8<>ABL ?@>5:B0 @0AAG8BK205BAO ?> D>@<C;5:

) / !" !" , = / !" !" , +

345:

- / !" !" , = AC<<0 AB>8<>AB59 2A5E :><?>=5=B>2 8 @01>B
- = <=>68B5;L 4;O ?>:@KB8O @8A:>2 8 =5?@542845==KE @0AE>4>2

5.2 !B@C:BC@0 107>2>9 AB>8<>AB8

07>20O AB>8<>ABL 2;;NG05B:

1. 0B5@80;K 8 :><?;5:BCNI85:

- -;5:B@>=8:0 (?@>F5AA>@K, :>=B@>;;5@K, 40BG8:8)
- 5E0=8:0 (?@>D8;L, =0?@02;ONI85, <>B>@K, @54C:B>@K)
- -;5:B@8:0 (:015;8, @07J5<K, 1;>:8 ?8B0=8O)
- UHF >1>@C4>20=85 (AG8BK20B5;8, 0=B5==K, <5B:8)
- ::C<C;OB>@K (LiFePO4 4;O UGV)
- >=AB@C:F8>==K5 <0B5@80;K (0;N<8=89, AB0;L)

2. 73>B>2;5=85 8 A1>@:0:

- 5E0=8G5A:0O >1@01>B:0 (D@575@>2:0, B>:0@:0)
- 075@=0O @57:0 <5B0;;0
- >@>H:>20O ?>:@0A:0
- !1>@:0 C7;>2 8 03@530B>2
- >=B06 M;5:B@>=8:8
- @>H82:0

3. @>3@0<<=>5 >15A?5G5=85:

- 07@01>B:0 WMS <>4C;59
- =B53@0F8O A ERP (040?B5@K 4;O 1C, SAP)
- Middleware (API Gateway, Message Queue)
- AI 0;3>@8B<K (?;0=8@>20=85, >?B8<870F8O)
- Dashboard 8 251-8=B5@D59AK
- >18;L=K5 ?@8;>65=8O

4. >=B06 8 ?CA:>=0;04:0:

- "@0=A?>@B8@>2:0 >1>@C4>20=8O
- #AB0=>2:0 AS-RS <>4C;59
- >=B06 UHF ?>@B0;>2
- @>;;04:0 :015;L=KE B@0AA
- 0AB@>9:0 A5B52>3> >1>@C4>20=8O
- 0;81@>2:0 8 B5AB8@>20=85
- 1CG5=85 ?5@A>=0;0

5.3 8;>B=K9 ?@>5:B: +30% @575@2=K9 D>=4

1>A=>20=85 @575@20 30% 4;O ?8;>B=>3> ?@>5:B0:

8;>B=K9 ?@>5:B - MB> ?5@2>5 2=54@5=85 B5E=>;>388, :>B>@>@8A:8:

' 0:C?:0 <0;KE ?0@B89 :><?>=5=B>2 (+10-15% : AB>8<>AB8)

- >AB02I8:8 40NB <5=LH85 A:84:8 ?@8 <0;KE >1J5<0E
- BACBAB285 >?B>2KE F5=
- >?>;=8B5;L=K5 ;>38AB8G5A:85 70B@0BK

' B;04:0 B5E=>;>38G5A:8E ?@>F5AA>2 (+5-10%)

- 5@28G=0O =0AB@>9:0 >1>@C4>20=8O B@51C5B 1>;LH5 2@5<
- >@01>B:0 :>=AB@C:F89 =0 >A=>25 B5AB8@>20=8O

• 73>B>2;5=85 4>?>;=8B5;L=KE :@5?5659 8 040?B5@>2

' 5?@542845==K5 B5E=8G5A:85 A;>6=>AB8 (+5-8%)

- @>1;5<K A>2<5AB8<>AB8 :><?>=5=B>2
- 5>1E>48<>ABL 70<5=K >B45;L=KE C7;>2
- >?>;=8B5;L=K5 4>@01>B:8

' 0AH8@5==>5 B5AB8@>20=85 (+3-5%)

- =>3>:@0B=K5 F8;;K ?@>25@:8
- !B@5AA-B5ABK 8 8A?KB0=8O
- >:C<5=B8@>20=85 @57C;LB0B>2

' 575@2 =0 4>@01>B:8 ?> B@51>20=8N 70:07G8:0 (+2-5%)

- >?>;=8B5;L=K5 DC=:F88
- 7<5=5=8O 2 A?5F8D8:0F8OE
- 0AB><870F8O ?>4 :>=:@5B=K5 =C64K

\$>@<C;0 @0AG5B0 ?8;>B0:

!B>8<>ABL " = 07>20O AB>8<>ABL × 1.30

@8<5@:

- 07>20O AB>8<>ABL UGV @>1>B0: 207,309 ½
- !B>8<>ABL 2 ?8;>B=>< ?@>5:B5: 207,309 × 1.30 = 269,502 ½

5.4 !5@89=>5 ?@>872>4AB2>: +25-30% =5?@542845==K5 @0AE>4

1>A=>20=85 @575@20 25-30% 4;O A5@89=>3> ?@>872>4AB20:

@8 A5@89=>< ?@>872>4AB25 B5E=>;>38O C65 >B@01>B0=0, =>

' 0:C?:0 :@C?=KE ?0@B89 (! -10-20%)

- ?B>2K5 F5=K >B ?>AB02I8:>2
- !=865=85 ;>38AB8G5A:8E 70B@0B =0 548=8FC
- 4=0:>: =5>1E>48< 70?0A =0 A;CG09 1@0:0

' B;065==K5 ?@>F5AAK (- / -5%)

- "8?>2K5 B5E=>;>38G5A:85 :0@BK
- >2B>@O5<>ABL >?5@0F89
- 5=LH5 2@5<5=8 =0 =0AB@>9:C

' : !>E@0=ONBAO @8A:8 (+25-30%)

- $>;510=8O :C@A020;NB (+5-10\%): 1>;LH8=AB2> :><?>=5=B>2$
- $7<5=5=85 F5= ?>AB02I8:>2 (+3-5\%): 8=D;OF8O, 45D8F8B :><?$
- $@0: 870<5=0 :><?>=5=B>2 (+3-5\%): @575@2 =0 1@0:>20==K5$
- $>38AB8G5A:85 8745@6:8 (+2-4\%): B0<>6=O, 4>AB02:0, E@0=5$
- $>?>;=8B5;L=K5 B@51>20=8O 70:07G8:0 (+5-8\%): :0AB><870F8$
- $0@0=B89=>5 >1A;C6820=85 (+2-3\%): @575@2 =0 30@0=B89=K$

$\$>@<C;0 @0AG5B0 A5@89=>3> ?@>872>4AB20:$

$!B>8<>ABL ! / = 07>20O AB>8<>ABL \times 1.25 4> 1.30$

$K1>@ <=>68B5;O (1.25 8;8 1.30):$

- $1.25 - 5A;8 2A5 :><?>=5=BK C65 2 =0;8G88, ?>AB02I8:8 =0456 >B@01>B0=K$
- $1.27-1.28 - A@54=89 A;CG09, B8?>2>9 ?@>5:B$
- $1.30 - 5A;8 5ABL @8A:8 A ?>AB02:0<8, A;>6=0O ;>38AB8:0, = B@51>20=8O$

$@8<5@:$

- $07>20O AB>8<>ABL 10 UGV @>1>B>2: 2,073,090 \frac{1}{2}$
- $!B>8<>ABL A5@89=0O (<=>68B5;L 1.27): 2,073,090 \times 1.27 = 2,$
- $!B>8<>ABL A5@89=0O (<=>68B5;L 1.30): 2,073,090 \times 1.30 = 2,$

5.5 !B@C:BC@0 @575@20 (45B0;870F8O)

$0A?@545;5=85 @575@2=>3> D>=40 30\% (?8;>B=K9 ?@>5:B):$

!B0BLO @0AE>	% >B 107>2> AB>8<>AB8	07=0G5=85
$>?>;=8B5;L=K :><?>=5=BK$	8-10%	$0:C?:0 @575@2=KE 45B0;59, 70<5=0 1@0:0$
$>@01>B:8 :>=AB@C:F89$	5-7%	$73>B>2;5=85 4>?>;=8B5;L=KE :@5?;5=89, 040?B5@>2$
$0AH8@5==>5 B5AB8@>20=85$	3-5%	$>?>;=8B5;L=K5 F8;;K ?@>25@:8, 8A?KB0=8O$
$8 8=B53@0F$	4-6%	$>@01>B:0 A>DB0, >B;04:0 API, 8A?@02;5=85 103>2$
$5?@542845==F @0AE>4K$	5-7%	$1I89 @575@2 =0 ;N1K5 =5>6840==>$
$1CG5=85 8 4>:C<5=B0F8O$	2-3%	$0AH8@5==>5 >1CG5=85 ?5@A>=0;0 <0=C0;K$
"	27-38%	$!@54=89 @575@2 30\%$

0 A ? @ 5 4 5 ; 5 = 8 5 @ 5 7 5 @ 2 0 2 5 - 3 0 % (A 5 @ 8 9 = > 5 ? @ > 8 7 2 > 4 A B 2 >) :

! B 0 B L O @ 0 A E :	% > B 1 0 7 > 2 > 9 A B > 8 < > A B 8	0 7 = 0 G 5 = 8 5
0 ; N B = K 5 @ 8 A	5-10%	> ; 5 1 0 = 8 O : C @ A 0 U S D / E U R / C N Y
> A B F 5 = ? > A B 0 2 I 8 : > 2	3-5%	= D ; O F 8 O , 8 7 < 5 = 5 = 8 5 ? @ 0 9 A > 2
@ 0 : 8 7 0 < 5 = 0	3-5%	5 7 5 @ 2 = 0 1 @ 0 : > 2 0 = = K 5 : > < ? > = 5
> 3 8 A B 8 : 0	2-4%	" 0 < > 6 = O , 4 > A B 0 2 : 0 , 7 0 4 5 @ 6 : 8
0 A B > < 8 7 0 F 8 O	5-8%	> @ 0 1 > B : 8 ? > 4 B @ 5 1 > 2 0 = 8 O 7 0 : 0 7 G 8 : 0
0 @ 0 = B 8 9 = K 9	2-3%	1 A ; C 6 8 2 0 = 8 5 ? > 3 0 @ 0 = B 8 8
1 I 8 9 @ 5 7 5 @ 2	3-5%	5 ? @ 5 4 2 8 4 5 = = K 5 A 8 B C 0 F 8 8
"	23-40%	! @ 5 4 = 8 9 @ 5 7 5 @ 2 2 7 - 3 0 %

5.6 @ 8 < 5 @ K @ 0 A G 5 B 0 A B > 8 < > A B 8

@ 8 < 5 @ 1 : U G V @ > 1 > B (1 5 4 8 = 8 F 0 , ? 8 ; > B)

0 7 > 2 0 O A B > 8 < > A B L : 2 0 7 , 3 0 9 ½
 5 7 5 @ 2 = K 9 D > = 4 (3 0 %) : 6 2 , 1 9 3 ½
 %
 " ? 8 ; > B = K 9 ? @ > 5 : B : 2 6 9 , 5 0 2 ½

@ 8 < 5 @ 2 : U G V @ > 1 > B K (1 0 5 4 8 = 8 F , A 5 @ 8 O)

0 7 > 2 0 O A B > 8 < > A B L 1 0 H B : 2 , 0 7 3 , 0 9 0 ½
 5 ? @ 5 4 2 8 4 5 = = K 5 (2 7 %) : 5 5 9 , 7 3 4 ½
 %
 " A 5 @ 8 9 = > 5 ? @ > 8 7 2 . : 2 , 6 3 2 , 8 2 4 ½

- : > = > < 8 O = 0 5 4 8 = 8 F C : 2 6 9 , 5 0 2 - 2 6 3 , 2 8 2 = 6 , 2 2 0 ½ (2.3 %)

@ 8 < 5 @ 3 : A S - R S < > 4 C ; L (1 5 4 8 = 8 F 0 , ? 8 ; > B)

0 7 > 2 0 O A B > 8 < > A B L : 9 0 5 , 0 0 0 ½
 5 7 5 @ 2 = K 9 D > = 4 (3 0 %) : 2 7 1 , 5 0 0 ½
 %
 " ? 8 ; > B = K 9 ? @ > 5 : B : 1 , 1 7 6 , 5 0 0 ½

@ 8 < 5 @ 4 : A S - R S < > 4 C ; 8 (5 5 4 8 = 8 F , A 5 @ 8 O)



5.7 >;8B8:0 A:84>: ?@8 <0AHB018@>20=88
@8 70:075 :@C?=KE ?0@B89 ?@8<5=ONBAO 4>?>;=8B5;L=K5 A:8

1J5< 70:070	!:84:0 >B 107>2>9 AB>8<>AB8	575@2
8;>B (1-2 54.)	0% (AB0=40@B=0O F5=0)	+30%
3-5 548=8F	-3%	+28%
6-10 548=8F	-5%	+27%
11-20 548=8F	-7%	+26%
21-50 548=8F	-10%	+25%
51+ 548=8F	> 4>3>2>@5==>AB8	+25%

@8<5@ A CG5B>< A:84:8:

20 UGV @>1>B>2:
07>20O AB>8<>ABL 20 HB: 4,146,180 ½
!:84:0 7%: -290,233 ½
07>20O A> A:84:>9: 3,855,947 ½
5?@542845==K5 (26%): 1,002,546 ½
%%%%%%%%%%
" 20 @>1>B>2: 4,858,493 ½

0 548=8FC: 242,925 ½ (M:>=><8O 26,577 ½ vs ?8;>B)

6. . ' + " - \$\$ " !"

6.1 "5E=8G5A:85 KPI

>:070B5;L	=0G5=85	!@02=5=85 A 0=0;>30<8
">G=>ABL ?>78F8>=8C ±0.5 <<AS-RS		CGH5 G5< Dematic (±2 <<
">G=>ABL =02830F88 ±0.5 A<		!>?>AB028<> A Amazon Kiva
!:>@>ABL >?5@0F89 A 90-120 >?/G0A		AutoStore: 100 >?/G0A
!:>@>ABL :><?;5:B0F8 150-200 70:07>2/A<5=C		"@048F8>==>: 30-40 70:07>2
">G=>ABL CG5B0 UHF 99.9%		(B@8E-:>4K: 95-98%

- $\emptyset = \ddot{U}^{\circ} \quad 0 \quad 70\% \quad 45H52;5 \quad >?5@0F8>==K5 \quad 70B@0BK$
- $' \quad 200 \times B > G = 55 \quad CG5B \quad (99.9\% \quad vs \quad 95-98\%)$

$V_s \quad 70@C156=K5 \quad 0=0;>38 \quad (\text{Amazon Kiva, AutoStore}):$

- $\emptyset = \ddot{U}_{\mu} \quad 3-8 \times 45H52;5 \quad AB>8<>ABL \quad A8AB5<K$
 - $\emptyset < \acute{Y} \div \emptyset < \acute{Y} \acute{u} \quad >;=0O \quad 8<?>@B>70<5I5=85 \quad - \quad @>AA89A:0O \quad @07@01>B:$
 - $\emptyset = \acute{Y}' \quad 53:>ABL \quad >1A;C6820=8O \quad - \quad 4>ABC?=>ABL \quad 70?G0AB59, \quad B5E?$
 - $\emptyset = \ddot{U}^{\grave{e}} \quad 81:0O \quad <0AHB018@C5<>ABL \quad - \quad <>4C;L=0O \quad 0@E8B5:BC@0$
- $. ' \quad \quad \quad \# \quad 0$

$><?;5:A=0O \quad A8AB5<0 \quad 02B><0B870F88 \quad A:;040 \quad ?@54AB02;O5B \quad A>1$
 $@5H5=85, \quad >1J548=ONI55:$

1. UHF RFID - $4;O \quad 02B><0B8G5A:>9 \quad 845=B8D8:0F88 \quad B>20@>2$
2. UGV $@>1>BK \quad - \quad 4;O \quad 02B>=><=>9 \quad B@0=A?>@B8@>2:8$
3. AS-RS $<>4C;8 \quad - \quad 4;O \quad ?;>B=>3> \quad 25@B8:0;L=>3> \quad E@0=5=8O$
4. AI $!5@25@ \quad - \quad 4;O \quad 8=B5;;5:BC0;L=>3> \quad C?@02;5=8O$
5. WMS + Middleware - $4;O \quad 8=B53@0F88 \quad A \quad 187=5A-?@>F5AA0<8$

$!8AB5<0 \quad 2=54@O5BAO \quad ?>MB0?=> \quad (7 \quad MB0?>2, \quad 16-28 \quad =545;L \quad 2 \quad 7028$
 $<0AHB018@C5BAO \quad 381:> \quad (>B \quad ?8;>B=>3> \quad ?@>5:B0 \quad A \quad 1 \quad @>1>B>< \quad 4$
 $@>1>B0<8 \quad 8 \quad 10 \quad <>4C;O<8 \quad AS-RS).$

$\&5=>>1@07>20=85 \quad ?@>7@0G=>5:$

- $8;>B=K9 \quad ?@>5:B: \quad 07>20O \quad AB>8<>ABL \quad + \quad 30\% \quad @575@2$
- $!5@89=>5 \quad ?@>872>4AB2>: \quad 07>20O \quad AB>8<>ABL \quad + \quad 25-30\% \quad @575$

$-DD5:B82=>ABL \quad 4>:070=0:$

- ROI: $18 \quad <5AOF52$
- $-:>=><8O: \quad 10 \quad <;= \quad \frac{1}{2}/3>4 \quad =0 \quad >?5@0F8>==KE \quad 70B@0B0E$
- $@>872>48B5;L=>ABL: \quad 2 \quad 4 \times \quad @07 \quad 2KH5 \quad B@048F8>==>3> \quad A:;040$

$!;54CNI89 \quad @0745;: \quad -" \quad 1 \quad - \quad =54@5=85 \quad UHF \quad RFID \quad <0@:8@>2:8$

$0B0 \quad ?>43>B>2:8: \quad 16 \quad =>O1@O \quad 2025$

$!B0BCA \quad 4>:C<5=B0: \quad \#B25@645=$

$5@A8O: \quad 1.1$