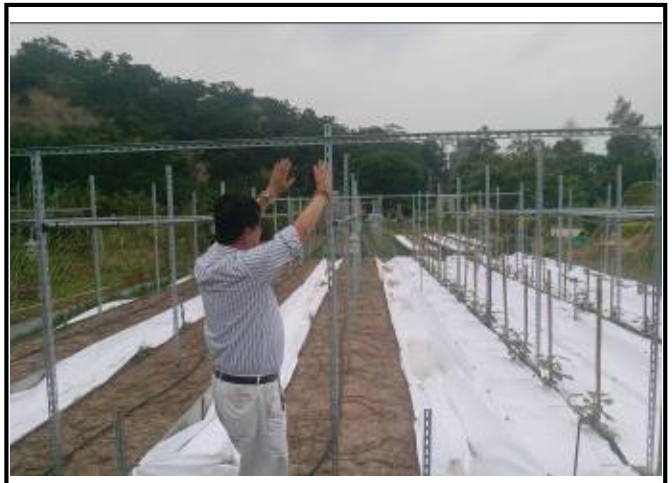
『AI artificial intelligence farm』 LoRa + 4G-LTE + PTP Mesh wireless monitoring transmission system planning and design

1.『AI Artificial Intelligence Farm』LoRa + 4G-LTE + PTP Mesh Wireless Transmission System Environment Definition

AI No. 1 Farm Area A



AI No.1 Farm B (Wireless System Standpoint)

AI No. 1 Farm Area C

AI No. 2 Farm Area A

AI No. 2 Farm Area B

AI No. 2 Farm Area C

2.『AI Artificial Intelligence Farm』various detection systems and transmission equipment

Detection Instrument - LoRa Gateway
400M~520MHz wireless transmission

Weather/detection equipment - LoRa Gateway
400M~520MHz wireless transmission

Detection Instrument
LoRa Transmission

Micro weather station -868MHz
FHSS wireless transmission

Detection Instrument
LoRa Transmission

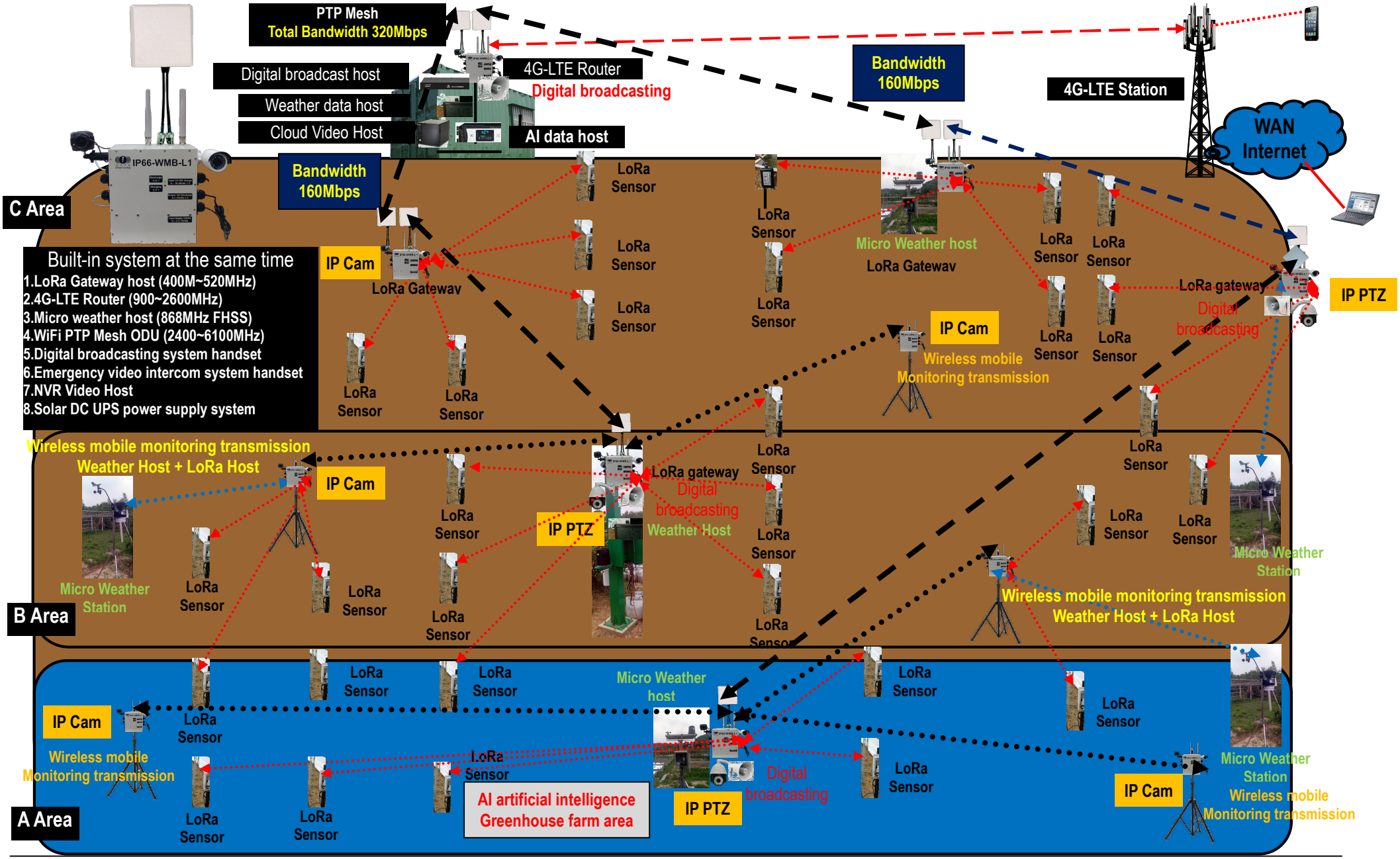
Detection Instrument Host
LoRa Transmission

Detection Instrument
LoRa Transmission

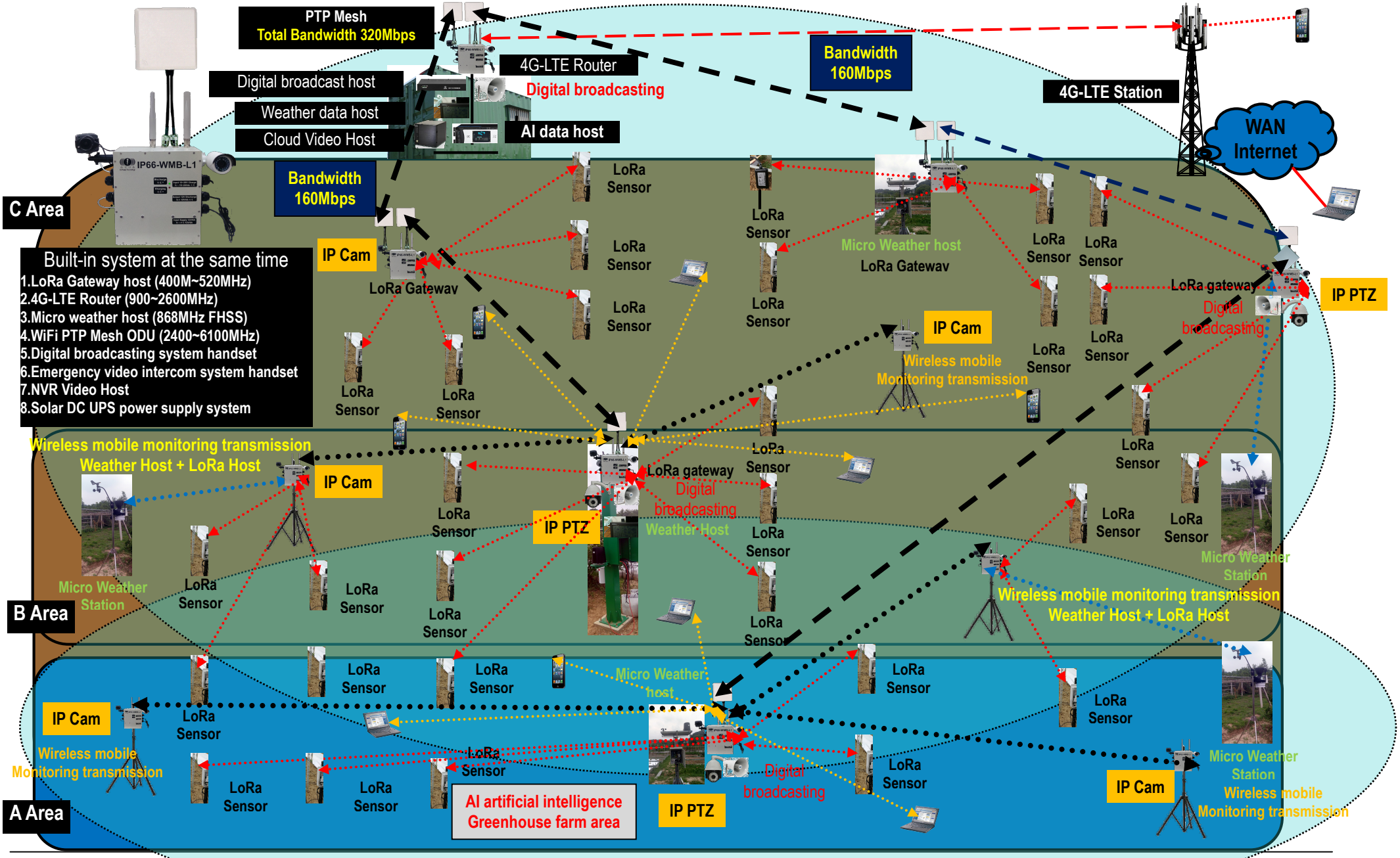
Micro weather station -868MHz
FHSS wireless transmission

Detection Instrument
LoRa Transmission

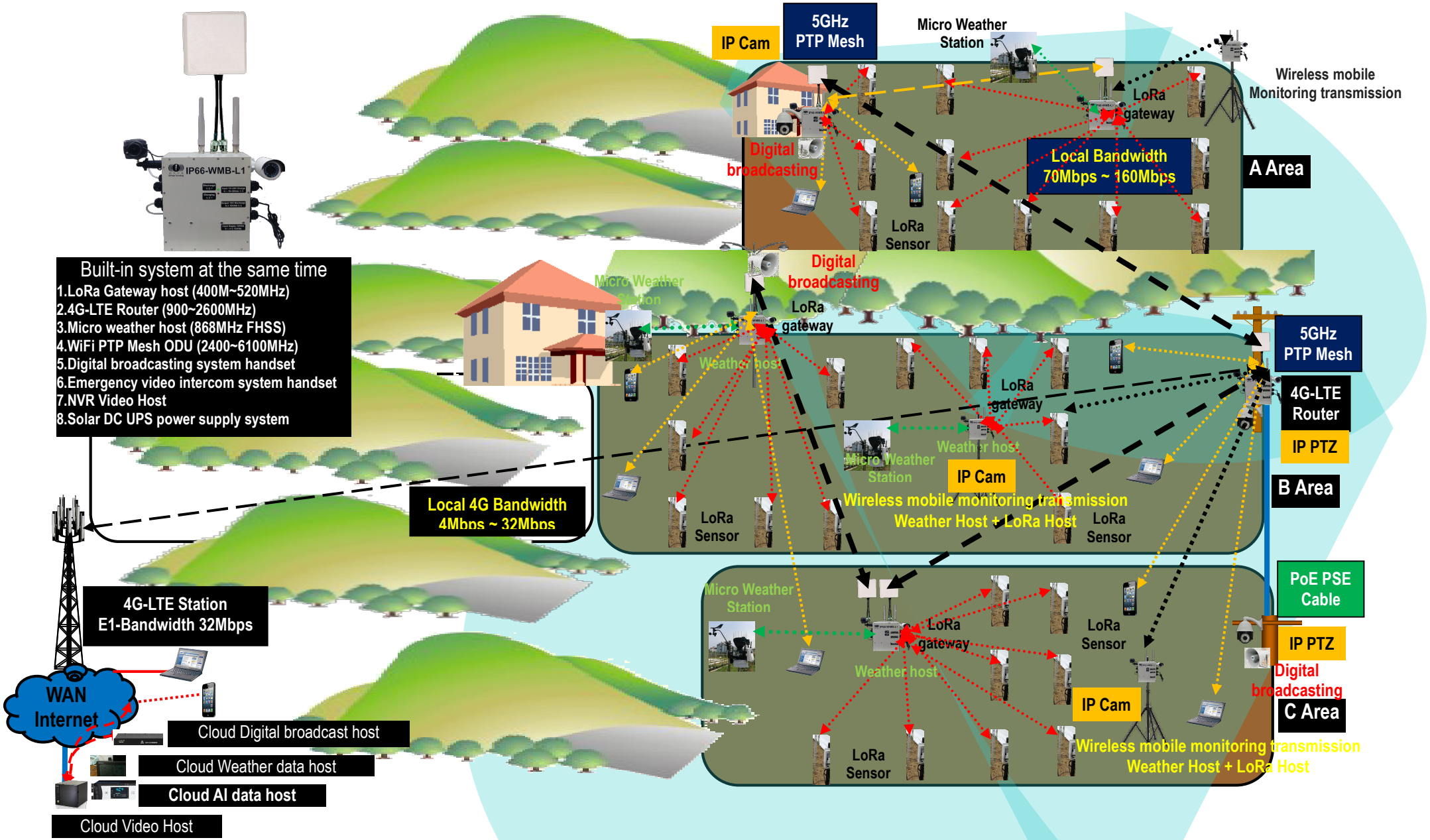
3.『No. 1 Farm』LoRa + 4G-LTE + Micro Weather station FHSS + PTP Mesh Wireless Monitoring Transmission System Design



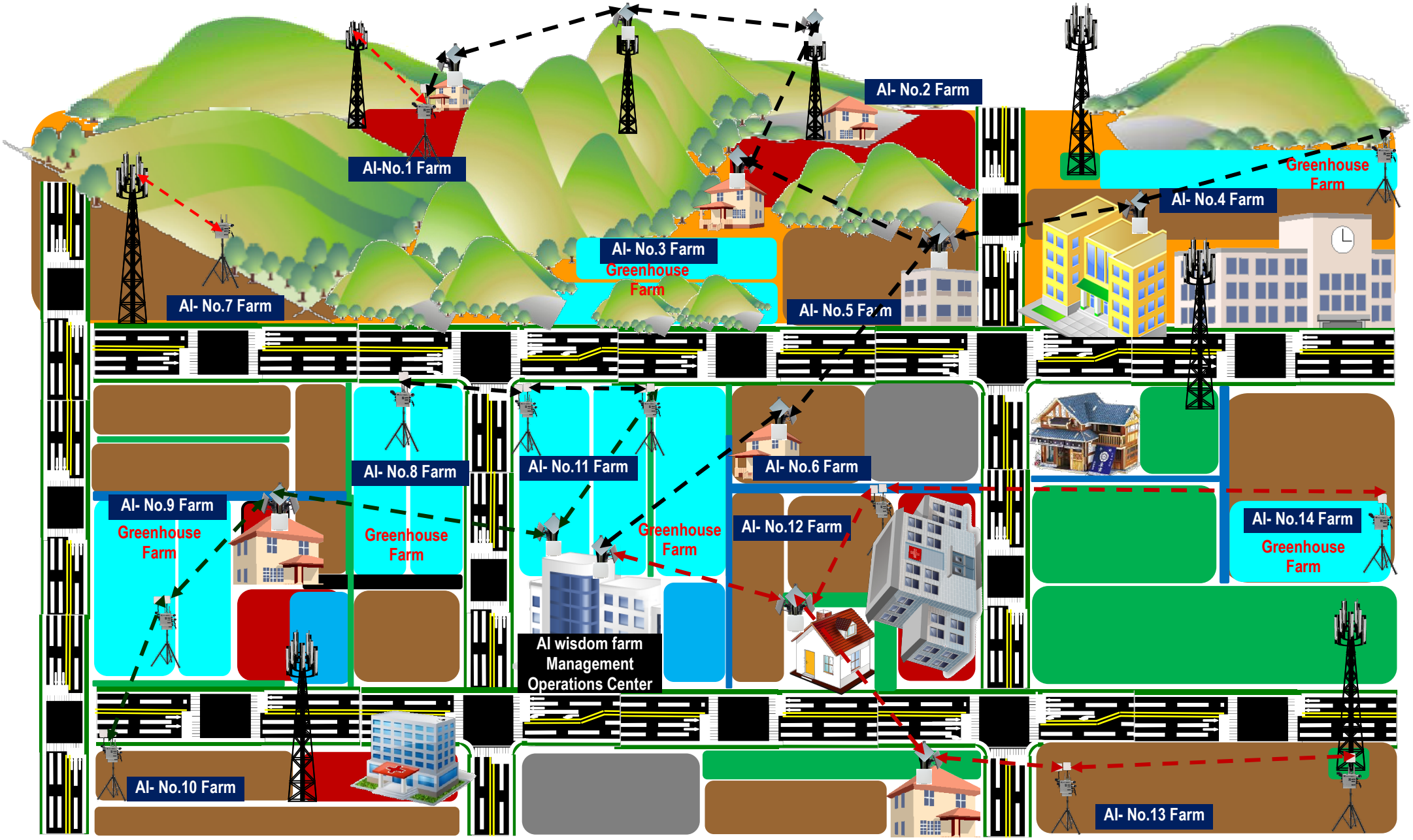
4.『No. 1 Farm』 LoRa + 4G-LTE + Micro Weather Station FHSS + PTP Mesh Wireless Monitoring / Internet Transmission System Design



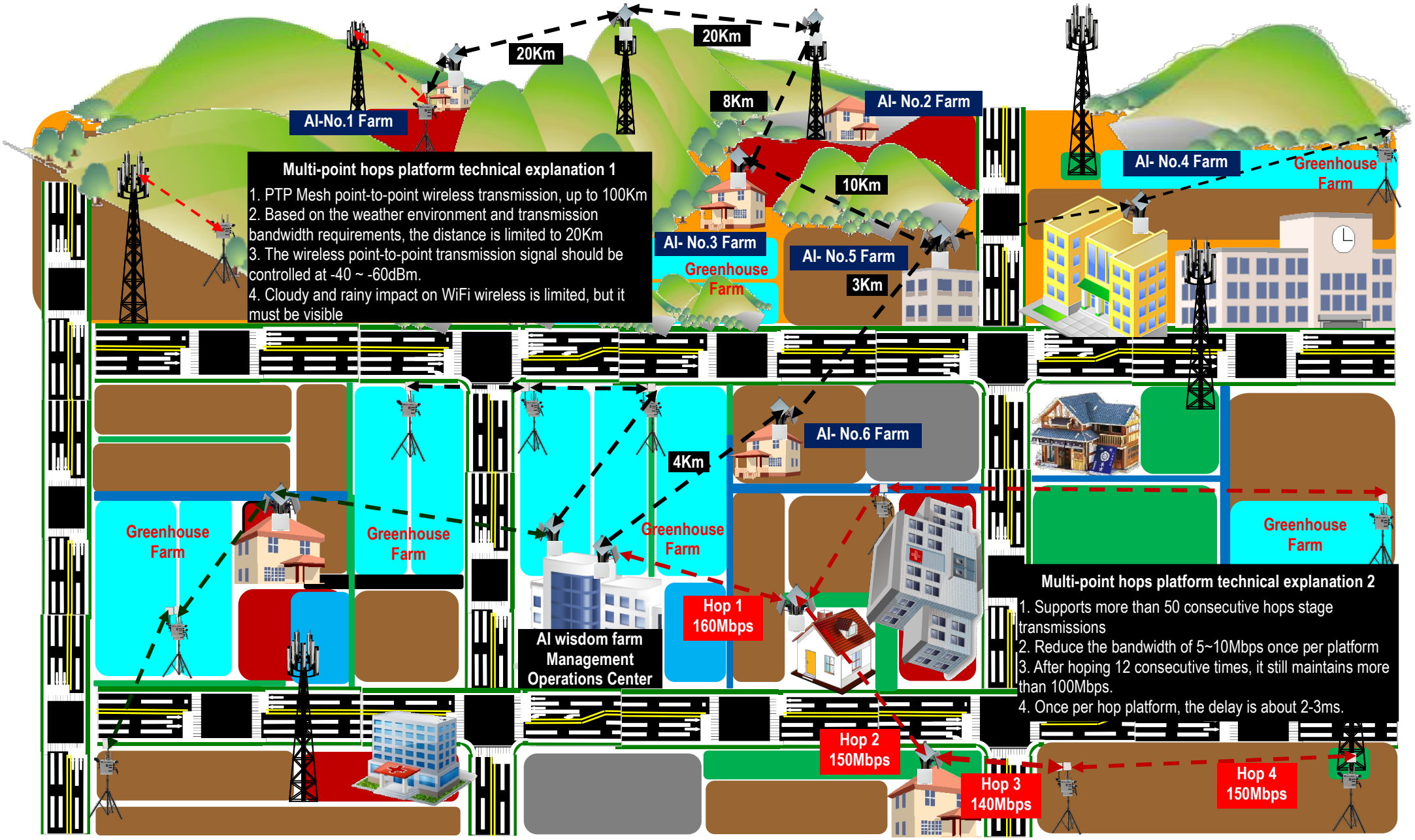
5.『No. 2 Farm』LoRa + 4G-LTE + Micro Weather Station FHSS + PTP Mesh Wireless Monitoring / Internet Transmission System Design



6.『Collection of 14 AI Smart Farms』LoRa + 4G-LTE + Micro Weather Station FHSS + PTP Mesh Wireless Transmission System Design



7.『Collection of 14 AI Wisdom Farms』PTP Mesh Multipoint Relay Platform Wireless Backhaul 65km System Design Description



8. Calculation of Rainfall Signal Attenuation Formula in Wireless Monitoring Transmission System

- Set the 1 Km rain attenuation values of 5 GHz for wireless transmission and calculate the rainfall at 100 mm/hr. Calculation result: The rain attenuation within 0.5 dBm.
- Set the 5 Km rain attenuation values of 5 GHz for wireless transmission and calculate the rainfall at 100 mm/hr. Calculation result: The rain attenuation is within 2 dBm.
- Set the10 Km rain attenuation values of 5 GHz for wireless transmission and calculate the rainfall at 100 mm/hr. Calculation result: The rain attenuation within 3.5 dBm.

2	WiFi 2.4 ~ 2.485GHz & 5.25 ~ 5.85GHz 電波大雨衰減(Rain Attenuation)估算 單位：dB													
3	PtP		2.4GHz ~ 2.485GHz Frequency						5GHz ~ 5.85GHz Frequency					
4	Rainfall Rate		100mm/hr			200mm/hr			100mm/hr			200mm/hr		
5	Km	EPD/Km	2.4	2.45	2.485	2.4	2.45	2.485	5.25	5.5	5.85	5.25	5.5	5.85
6	1	0.64	0.06	0.07	0.07	0.15	0.16	0.16	0.41	0.46	0.53	0.96	1.07	1.23
10	5	2.88	0.28	0.3	0.31	0.66	0.7	0.72	1.85	2.06	2.38	4.29	4.78	5.5
15	10	5.11	0.5	0.52	0.54	1.18	1.24	1.28	3.27	3.65	4.21	7.6	8.46	9.75

Note 1: According to the practical experience of Taiwan's environment, the 5 GHz wireless rain attenuation at 5 km of typhoon days is within about 2 dB, and the rain attenuation at No.88 typhoon of 30 km wireless transmission is about 2 dB. The actual measurement results only affect the signal quality of 2 dBm, but the 30 Km transmission bandwidth is not Affected.

Note 2: The effect of dense fog on the wireless transmission of WiFi 5GHz is lower than that of rain attenuation. Since it was installed on the 5 islands of Mazu and on the south side of the island in 2010, it has not been affected by Mazu's dense fog for the duration and stability of wireless transmission for 5 years. (The signal strength is attenuated within 2dBm as well as rain attenuation).

Note 3: The increasingly serious smog problem in the mainland, in theory, should affect the signal attenuation of wireless transmission. The long-term observation of the wireless transmission signal results has proved to be influential, but it has also reached only about 2dBm signal value. It has not been observed yet. Seriously affect the phenomenon.

Note 4: The above table is purely theoretically calculated values. In practice, the value of rain attenuation in wireless transmission seldom exceeds 2 dB, which affects the wireless signal value as less than 2 dBm. Therefore, the wireless transmission link calculation is defined by a rain attenuation value of 2 dBm.

9. Wireless monitoring transmission system transmission signal estimation

■ Wireless backbone transmission signal value calculation:

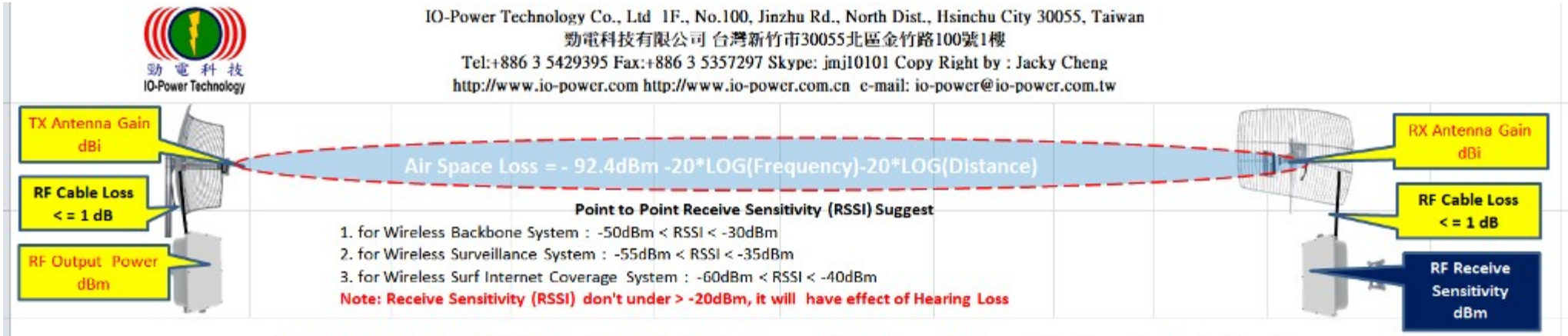
According to the designed multi-point hops platform, the point-to-point distance is mostly within 10Km (up to 20km)

➔It is recommended to use 5GHz 16dBi directional plate antenna for mounting points within 2Km

➔It is recommended to use 5 GHz 20dBi directional plate antenna for mounting points within 5Km

➔It is recommended that a 5GHz 23dBi directional plate antenna should be used within 12Km to set up points (distances over 12Km and 31dBi Grid/Dish antennas are recommended)

It can obtain the estimated strength of the wireless backbone connection signal of -60dBm or more, and can reach a full-speed transmission bandwidth of 160Mbps.



無線鏈路訊號值(dBm)計算 (Wireless PtP Signal Sensitivity Calculation)

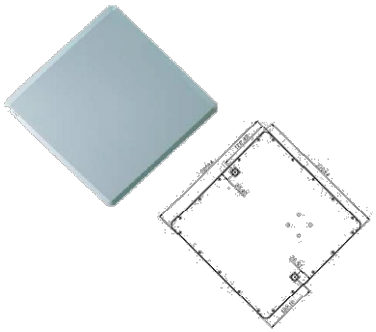
傳輸鏈路訊號計算 (Signal Selectivity Calculation)	RF Output Power dBm (Maxmium)	RF Cable Loss dB (1m=0.6dB)	TX Antenna Gain dBi	Space Loss = 92.4	Frequence Loss GHz	Distance Loss Km	Rain Loss = 2 dB	Tree Loss 1m=5dB	RX Antenna Gain dBi	RF Cable Loss Db (1m=0.6dB)
參數定義 (Parameter Definition)	無線最大輸出功率	RF線損耗	天線增益	空間衰減	頻率衰減	距離衰減	雨衰	樹衰	天線增益	RF線損耗
請填入數據 (Please fill in your data)	23	1	20	92.4	5.45	5	0	0	20	1
計算結果 (Calculation Results)	-60.11									

10. Set up equipment inventory quantity

Outdoor PTP MESH Wireless Transmission System Equipment List					
No.	**Device name**	**Equipment model**	**Brief specifications**	**Quantity**	**Remark**
1	**IO-Power Technology IOP-IP66-WMB-L1 Series -- With multi-functional integration and extended expansion capabilities** 	**IOP-E1PX-XXXX-PSED-000** 	1. Built-in outdoor PTP Mesh wireless transmission device EL-N-1 with anti-interference box 2. Supports 2x2 MIMO 802.11an Transmission Data Rate 300Mbps/ Bandwidth Traffic 160Mbps 3. Built-in PS-PoE Passive mode power supply 72W 4. Built-in RJ-45 Ethernet lightning surge protector 5. Built-in 1DC to 4DC lightning surge protector 6. Stainless steel rod / wall / lamp post holder 7. Explosion-proof DC UPS temporary power outage 4 hours power supply and voltage supply protection **The scalable built-in system includes:** 1. LoRa Gateway Host (400M~520MHz) 2. 4G-LTE Router (900~2600MHz) 3. Micro Weather Host (868MHz FHSS) 4. WiFi PTP Mesh Base Station (2400~6100MHz) 5. Digital Broadcast Subunit 6. NVR Video Host 7. Solar High-Temperature Solar DC UPS Power Supply System		

2	**PTP wireless Mesh network base station**	**EL-N-1 (1 Module)**	1. One WiFi MIMO 2 * 2 4.9 ~ 6.1GHz wireless single-band RF module (802.11an) 2. System Operation PTP Mesh Point-to-point multipath network connection transmission 3. Wireless output power single-frequency network card 23dBm 4. Support PTP Mesh / AP / AP-STA modes 5. After 10 times the hops, still can maintain the following response delay of 15ms 6. Support IGMP broadcast packet protocol features 7. The largest backbone bandwidth 200Mbps (40MHz) 8. Wireless with cable cascading> = 8hops maximum bandwidth 150Mbps(40MHz)		
3	**PTP wireless Mesh network base station**	**EL-N-2 (2 Modules)**	1. Two WiFi MIMO 2 * 2 4.9 ~ 6.1GHz wireless single-band RF module (802.11an) 2. System Operation PTP Mesh Point-to-point multipath network connection transmission 3. Wireless output power single-frequency network card 23dBm 4. Support PTP Mesh / AP / AP-STA modes 5. After 10 times the hops, still can maintain the following response delay of 15ms 6. Support IGMP broadcast packet protocol features 7. The largest backbone bandwidth 300Mbps (40MHz) 8. Wireless with cable cascading> = 8hops maximum bandwidth 150Mbps(40MHz)		

4	**PTP wireless Mesh network base station**	**EL-N-3 (3 Modules)**	1. Three WiFi MIMO 2 * 2 4.9 ~ 6.1GHz wireless single-band RF module (802.11an) 2. System Operation PTP Mesh Point-to-point multipath network connection transmission 3. Wireless output power single-frequency network card 23dBm 4. Support PTP Mesh / AP / AP-STA modes 5. After 10 times the hops, still can maintain the following response delay of 15ms 6. Support IGMP broadcast packet protocol features 7. The largest backbone bandwidth 320Mbps (40MHz) 8. Wireless with cable cascading> = 8hops maximum bandwidth 150Mbps(40MHz)		
5	**2.4GHz 4dBi & 5GHz 7dBi Dual Band Omni Antenna**	**IOP-OANMO-580536025**	1.Frequence: 2400~2500MHz;5150~5875 MHz 2.Gain: 4dBi@2.4GHz; 7dBi@5GHz 3.HPBW / Horizontal 360° 4.HPBW / Vertical 30° 5.Connector: N-Type Plug * 1 6.Weight: 0.07Kg 7.Size:Φ22 × 183 mm		
6	**Base station with MIMO antenna Plane-Oriented Medium Gain Antenna**	**IOP-PANJO-5M1602422**	1. Pointing plate antenna 2.5GHz 15-16dBi Outdoor Antenna 3. Frequency range: 5.150-5.875GHz 4. Horizontal / Vertical Angle: Horizontal: 17-24° /Vertical : 17-24° 5. Connector: RG233, 70cm & N Jack × 2 6. Dimensions: 210 x 210 x 73 mm 7. IPX5, resistant to wind pressure 216Km/hr		

7	**Outdoor WiFi MIMO 5GHz 20dBi Dual Linear Panel Antenna**	**IOP-PANFO-5M2001010** 	1.Frequence:5150 - 5875 MHz 2.Gain: 20dBi 3.Polarization : Dual Linear +- 45° 4. HPBW / Horizontal : H:10° / V:10° 5.Connector: N-Type Jack * 2 6.Weight: 1.24Kg 7.Dimensions: 320 × 320 × 20 mm 8.IP67 9.Survival wind speed: 216Km/hr		
8	**Outdoor WiFi MIMO 5GHz 23dBi Dual Linear Panel Antenna**	**IOP-PANFO-5M2300808**	1.Frequence:4900 - 5875 MHz 2.Gain: 23dBi 3.Polarization : Dual Linear +- 90° 4. HPBW / Horizontal : H:8° / V:8° 5.Connector: N-Type Jack * 2 6.Weight: 2.5Kg 7.Dimensions: 371 × 371 × 165 mm 8.IPX7 9.Survival wind speed: 216Km/hr		
9	**Antenna RF Cable CFD400 1.5M RF Cable**	**IOP-RFCFD-400150NMR**	1. Connector: N-type Plug to N-type Plug 2. Cable: CFD-400 1.5M 3. Temp: - 40 ~ + 85°C 4. Impedance: 50Ω 5. Shielding Effectiveness: >= 90dB 6. Weight: 0.3Kg		
10	**RF Connector Self-Bonding Rainproof Insulating Tape**	**IOP-RMTOC-173830510B**	1. Length / roll: 305cm ± 2cm 2. Width: 38mm ± 2mm 3. Thickness: 1.35mm ± 0.5mm		

			4. Elongation: 1000% 5. Adhesion: Detachment < 2cm 6. Breaking Strength: >2kg 7. Water Absorption: <0.2% 8. Insulation Resistance: >1 × 106 MΩ+		
11	**Outdoor Industrial 4G-LTE Router**	**4G Router -- R200LC** 	1. Support 4G-LTE, backward compatible with 3G networks 2. Support WEP, WPA / WPA2 / TKIP / AES and other authentication and encryption methods 3. Support virtual data and private network (APN/VPDN) 4. Support TCP/IP protocol, Telnet, HTTP, SNMP, PPP, PPPoE and other network protocols 5. Support VPN Client (PPTP, L2TP), Open VPN, IPSec, HTTPs, SSH, etc. 6. R200LC supports 1Port LAN & 1Port WAN or Dual LAN Port		
12	**WiFi Wireless Mobile Monitoring**	**IOP-E1PX-XXXX-PSED-001** 	1. Built-in outdoor PTP Mesh wireless transmission device EL-N-1 with anti-interference box 2. Supports 2x2 MIMO 802.11an Transmission Data Rate 300Mbps/ Bandwidth Traffic 160Mbps 3. Built-in PS-PoE Passive mode power supply 72W 4. Built-in RJ-45 Ethernet lightning surge protector 5. Built-in 1DC to 4DC lightning surge protector 6. Explosion-proof DC UPS temporary power outage 4 hours power supply and voltage supply protection **The scalable built-in system includes:** 1. LoRa Gateway Host (400M~520MHz) 2. 4G-LTE Router (900~2600MHz) 3. Micro Weather Host (868MHz FHSS)		