

STPA analysis of Drone Delivery System

To be reviewed

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Step One - Purpose of the Analysis

Goals

G-1: Delivery package to the right client.

G-2: Make a safe flight.

Assumptions

A-1: The Drone has software that is able to dodge birds and other objects such as power lines.

A-2: The Drone has a reliable internet connection.

A-3: The Drone have periodical maintenance.

A-4: The Drone will only take off after the approval of the flight plan and enough battery to make the delivery and return to the Drone Delivery System (DDS).

A-5: Each drone sends periodically status to the server about its position and information.

A-6: The drone flies autonomously.

A-7: The Customer is able to cancel the delivery until 15 minutes before the scheduled takeoff time.

A-8: The Store has the products and sells them to the Customer. The Store is responsible to keep the products and send the products to DDS.

A-9: The Drones accepts only one size box to make delivery, only carry boxes weighing less than 5 pounds (approximately 2.2 Kg), and make delivery up to 3 kilometers in diameter. Each delivery must respect this restriction.

A-10: During the hovering process, the Drone gets close to the ground to safely release the payload.

A-11: The Customer will position a plate with a QR code sign in a place with ample space for the Drone to deliver the product. The QR code is unique and provided by Store to the Customer.

A-12: The Drone start from DDS, makes only one delivery peer time at the customer, and returns to de DDS.

A-13: We assume that this process to release the payload is reliable.

Losses

L-1: Loss of drone.

L-2: Loss of package.

L-3: Damage the drone or environment.

L-4: Death or injury to people.

System-level Hazards

H-1: Lose the package or delivery in the wrong place. [L-2]

H-2: The Drone is forced to land in the wrong place due to weather conditions. [L-1] [L-2]

H-3: The Drone is forced to land in the wrong place due to drone problems. [L-1] [L-2]

H-4: Someone steals the drone. [L-1] [L-2]

H-5: The Drone collides with a person/object/animal during the flight. [L-3] [L-4]

H-6: The Drone invades the aerial space of another drone [L-1] [L-2] [L-3] [L-4]

H-7: Delay or non-delivery of the package. [L-2]

Systel-level Safety Constraints

SSC-1: The package must be delivered to the right place. [H-1] [H-7]

SSC-2: The DDS must have several secure areas to land the drone in case of emergency. [H-2] [H-3]

SSC-3: The DDS must maintain the drone periodically. [H-3]

SSC-4: The drone must be tracked and have protection to prevent leakage of customer information. [H-4]

SSC-5: The drone must have collision avoidance software. [H-5]

SSC-6: The drone must have a flight plan accepted before the takeoff. [H-6]

SSC-7: The drone must only flight in the route delimited in the flight plan. [H-6]

Step Two - Control Structure

Controller Distribution center

Responsibilities:

Outgoing connections

Distribution center -> DDS

Control actions: Request flight plans, Request a flight plan, Cancel a flight, Request status

Distribution center -> Virtual store

Incoming connections

Virtual store -> Distribution center

DDS -> Distribution center

Feedbacks (variables and values):

Request status (Accepted, Not accepted)

Delivery status (Not delivered, Delivery in process, Delivered, Problems to delivery)

List of periods (No period, List of periods)

Controller Customer

Responsibilities:

Outgoing connections

Customer -> Virtual store

Control actions: Request the period for delivery

Incoming connections

Virtual store -> Customer

Feedbacks (variables and values):

Request status (Accepted, Not accepted)

Delivery status (Not delivered, Delivery in process, Delivered, Problems to delivery)

List of periods (No period, List of periods)

Controller DDS

Responsibilities:

Outgoing connections

DDS -> Drone

Control actions: Start flight, Back to home, Go to position, Update drone system

DDS -> USS

Control actions: Request flight intentions, Request flight plan, Cancel flight plan

DDS -> Distribution center

Incoming connections

Weather system -> DDS

Feedbacks (variables and values):

Weather information (Good conditions for flight, Inappropriate for flight)

Distribution center -> DDS

USS -> DDS

Feedbacks (variables and values):

Flight plan status (Approved, Denied)

Flight cancelled (True, False)

Flight intentions (No flights, List of flights)

Drone -> DDS

Feedbacks (variables and values):

Drone battery (Battery ok, Low battery)

Drone position (GPS position, Unidentified)

Emergency situation (True, False)

Drone delivery status (At home, Flying, Hovering, Emergency landing)

Delivery status (Done, Undone)

Returning to base (True, False)

Operating system version (Updated, Update required)

Controller SARPAS (external of analysis)

Responsibilities:

Outgoing connections

SARPAS -> USS

Control actions: Install, Stop, Restart, Maintenance

Incoming connections

USS -> SARPAS

Feedbacks (variables and values):

Installation status (Installed, Installing, Not installed)

Server status (Started, Stopped)

Maintenance status (Under maintenance, Working)

Controller USS (external of analysis)

Responsibilities:

Outgoing connections

USS -> SARPAS

USS -> DDS

Incoming connections

DDS -> USS

Feedbacks (variables and values):

Flight intentions (List of flights intentions, No flights)

SARPAS -> USS

Feedbacks (variables and values):

Maintenance status (Under maintenance, Working)

Server status (Started, Stopped)

Controller Virtual store

Responsibilities:

Outgoing connections

Virtual store -> Distribution center

Control actions: Request the period for delivery

Virtual store -> Customer

Incoming connections

Customer -> Virtual store

Distribution center -> Virtual store

Feedbacks (variables and values):

Request status (Accepted, Not accepted)

Delivery status (Not delivered, Delivery in process, Delivered, Problems to delivery)

List of periods (No period, List of periods)

Controller Drone

Responsibilities:

Outgoing connections

Drone -> Compartment actuator

Control actions: Release package

Drone -> DDS

Incoming connections

DDS -> Drone

Package sensor -> Drone

Feedbacks (variables and values):

Package status (Package locked, Package delivered)

Camera -> Drone

Feedbacks (variables and values):

QR code (QR code, Not identified)

Distance sensor -> Drone

Feedbacks (variables and values):

Ground distance (Safe to release the payload, Unsafe to release the payload)

Cellular network positioning -> Drone

Feedbacks (variables and values):

Drone position (GPS position, Unidentified)

GPS positioning -> Drone

Feedbacks (variables and values):

Drone position (GPS position, Unidentified)

Actuator Compartment actuator

Outgoing connections

Compartment actuator -> Delivery process

Incoming connections

Drone -> Compartment actuator

Sensor Package sensor

Outgoing connections

Package sensor -> Drone

Incoming connections

Delivery process -> Package sensor

Sensor Camera

Outgoing connections

Camera -> Drone

Incoming connections

Delivery process -> Camera

Sensor Distance sensor

Outgoing connections

Distance sensor -> Drone

Incoming connections

Delivery process -> Distance sensor

External System Weather system

Outgoing connections

Weather system -> DDS

Incoming connections

External System Cellular network positioning

Outgoing connections

Cellular network positioning -> Drone

Incoming connections

External System GPS positioning

Outgoing connections

GPS positioning -> Drone

Incoming connections

Controlled Process Delivery process

Outgoing connections

Delivery process -> Package sensor

Delivery process -> Camera

Delivery process -> Distance sensor

Incoming connections

Compartment actuator -> Delivery process

Input: Packages to deliver

Output: Package delivered/not delivered.

Environmental Disturbances: Birds, Drones, Objects

Step Three - Unsafe Control Actions

Unsafe Control Actions (UCA) and Safety Constraints (SC)

Recommendation 1: (Controller: Customer - Control Action: Request the period for delivery)

UCA-1: Customer not provided Request the period for delivery in any context. [H-7]

Description:

SC-1: Customer must provide Request the period for delivery in any context.

Recommendation 2: (Controller: DDS - Control Action: Request flight plan)

UCA-2: DDS not provided Request flight plan when Drone delivery status is At home. [H-7]

Description:

SC-2: DDS must provide Request flight plan when Drone delivery status is At home.

Recommendation 3: (Controller: DDS - Control Action: Request flight plan)

UCA-3: DDS provided too late Request flight plan when Drone delivery status is Flying. [H-6]

Description: Em dúvida sobre essa UCA.

SC-3: DDS must not provide too late Request flight plan when Drone delivery status is Flying.

Recommendation 4: (Controller: DDS - Control Action: Cancel flight plan)

UCA-4: DDS provided Cancel flight plan when Drone delivery status is Flying. [H-6]

Description:

SC-4: DDS must not provide Cancel flight plan when Drone delivery status is Flying.

Recommendation 5: (Controller: DDS - Control Action: Start flight)

UCA-5: DDS not provided Start flight when Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False, Flight plan status is Approved. [H-6][H-7]

Description: The product must be delivered.

SC-5: DDS must provide Start flight when Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False, Flight plan status is Approved.

Recommendation 6: (Controller: DDS - Control Action: Start flight)

UCA-6: DDS provided Start flight when Flight plan status is Denied. [H-6]

Description:

SC-6: DDS must not provide Start flight when Flight plan status is Denied.

Recommendation 7: (Controller: DDS - Control Action: Start flight)

UCA-7: DDS provided Start flight when Flight cancelled is True. [H-1][H-2][H-6]

Description:

SC-7: DDS must not provide Start flight when Flight cancelled is True.

Recommendation 8: (Controller: DDS - Control Action: Start flight)

UCA-8: DDS provided Start flight when Drone battery is Low battery. [H-3][H-4][H-5][H-6]

Description:

SC-8: DDS must not provide Start flight when Drone battery is Low battery.

Recommendation 9: (Controller: DDS - Control Action: Start flight)

UCA-9: DDS provided Start flight when Weather information is Inappropriate for flight.
[H-1][H-2][H-3][H-4][H-5][H-6][H-7]

Description:

SC-9: DDS must not provide Start flight when Weather information is Inappropriate for flight.

Recommendation 10: (Controller: DDS - Control Action: Start flight)

UCA-10: DDS provided Start flight when Emergency situation is True.
[H-1][H-2][H-3][H-4][H-5][H-6][H-7]

Description:

SC-10: DDS must not provide Start flight when Emergency situation is True.

Recommendation 11: (Controller: DDS - Control Action: Start flight)

UCA-11: DDS provided too early Start flight when Flight plan status is Denied. [H-6]

Description:

SC-11: DDS must not provide too early Start flight when Flight plan status is Denied.

Recommendation 12: (Controller: DDS - Control Action: Start flight)

UCA-12: DDS provided too late Start flight when Flight plan status is Approved, Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False. [H-6][H-7]

Description: The Drone must respect the schedule.

SC-12: DDS must not provide too late Start flight when Flight plan status is Approved, Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False.

Recommendation 13: (Controller: DDS - Control Action: Back to home)

UCA-13: DDS not provided Back to home when Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False, Flight plan status is Approved. [H-4][H-6]

Description:

SC-13: DDS must provide Back to home when Weather information is Good conditions for flight, Drone battery is Battery ok, Emergency situation is False, Flight plan status is Approved.

Recommendation 14: (Controller: DDS - Control Action: Back to home)

UCA-14: DDS provided Back to home when Flight plan status is Denied. [H-6]

Description:

SC-14: DDS must not provide Back to home when Flight plan status is Denied.

Recommendation 15: (Controller: DDS - Control Action: Back to home)

UCA-15: DDS provided Back to home when Flight cancelled is True. [H-6]

Description:

SC-15: DDS must not provide Back to home when Flight cancelled is True.

Recommendation 16: (Controller: DDS - Control Action: Back to home)

UCA-16: DDS provided Back to home when Drone battery is Low battery. [H-3][H-5]

Description:

SC-16: DDS must not provide Back to home when Drone battery is Low battery.

Recommendation 17: (Controller: DDS - Control Action: Back to home)

UCA-17: DDS provided Back to home when Weather information is Inappropriate for flight. [H-1][H-2][H-3][H-4][H-5][H-6][H-7]

Description:

SC-17: DDS must not provide Back to home when Weather information is Inappropriate for flight.

Recommendation 18: (Controller: DDS - Control Action: Back to home)

UCA-18: DDS provided Back to home when Emergency situation is True.
[H-1][H-2][H-3][H-4][H-5][H-6][H-7]

Description:

SC-18: DDS must not provide Back to home when Emergency situation is True.

Recommendation 19: (Controller: DDS - Control Action: Back to home)

UCA-19: DDS provided too early Back to home when Weather information is Good conditions for flight, Emergency situation is False. [H-6][H-7]

Description: FIX

SC-19: DDS must not provide too early Back to home when Weather information is Good conditions for flight, Emergency situation is False.

Recommendation 20: (Controller: DDS - Control Action: Back to home)

UCA-20: DDS provided too late Back to home when Flight plan status is Approved.
[H-4][H-6][H-1]

Description:

SC-20: DDS must not provide too late Back to home when Flight plan status is Approved.

Recommendation 21: (Controller: DDS - Control Action: Go to position)

UCA-21: DDS not provided Go to position when Weather information is Inappropriate for flight, Drone delivery status is Flying. [H-2][H-5][H-6]

Description:

SC-21: DDS must provide Go to position when Weather information is Inappropriate for flight, Drone delivery status is Flying.

Recommendation 22: (Controller: DDS - Control Action: Go to position)

UCA-22: DDS not provided Go to position when Weather information is Inappropriate for flight, Drone delivery status is Hovering. [H-2][H-5][H-6]

Description:

SC-22: DDS must provide Go to position when Weather information is Inappropriate for flight, Drone delivery status is Hovering.

Recommendation 23: (Controller: DDS - Control Action: Go to position)

UCA-23: DDS not provided Go to position when Emergency situation is True, Drone delivery status is Flying. [H-3][H-5][H-6]

Description:

SC-23: DDS must provide Go to position when Emergency situation is True, Drone delivery status is Flying.

Recommendation 24: (Controller: DDS - Control Action: Go to position)

UCA-24: DDS not provided Go to position when Emergency situation is True, Drone delivery status is Hovering. [H-3][H-5][H-6]

Description:

SC-24: DDS must provide Go to position when Emergency situation is True, Drone delivery status is Hovering.

Recommendation 25: (Controller: DDS - Control Action: Go to position)

UCA-25: DDS provided Go to position when Flight plan status is Denied. [H-3][H-5][H-6][H-7]

Description:

SC-25: DDS must not provide Go to position when Flight plan status is Denied.

Recommendation 26: (Controller: DDS - Control Action: Go to position)

UCA-26: DDS provided Go to position when Weather information is Inappropriate for flight, Drone delivery status is At home. [H-1][H-2][H-3][H-4][H-5][H-6][H-7]

Description:

SC-26: DDS must not provide Go to position when Weather information is Inappropriate for flight, Drone delivery status is At home.

Recommendation 27: (Controller: DDS - Control Action: Go to position)

UCA-27: DDS provided too late Go to position in any context. [H-2][H-3][H-1][H-6][H-4]

Description:

SC-27: DDS must not provide too late Go to position in any context.

Recommendation 28: (Controller: DDS - Control Action: Update drone system)

UCA-28: DDS provided in wrong order Update drone system when Drone delivery status is Flying. [H-3][H-5]

Description:

SC-28: DDS must not provide in wrong order Update drone system when Drone delivery status is Flying.

Recommendation 29: (Controller: DDS - Control Action: Update drone system)

UCA-29: DDS provided in wrong order Update drone system when Drone delivery status is Hovering. [H-3][H-5]

Description:

SC-29: DDS must not provide in wrong order Update drone system when Drone delivery status is Hovering.

Recommendation 30: (Controller: DDS - Control Action: Update drone system)

UCA-30: DDS provided in wrong order Update drone system when Drone delivery status is Emergency landing. [H-3][H-5]

Description:

SC-30: DDS must not provide in wrong order Update drone system when Drone delivery status is Emergency landing.

Recommendation 31: (Controller: DDS - Control Action: Update drone system)

UCA-31: DDS provided Update drone system when Operating system version is Updated. [H-7]

Description:

SC-31: DDS must not provide Update drone system when Operating system version is Updated.

Recommendation 32: (Controller: DDS - Control Action: Update drone system)

UCA-32: DDS not provided Update drone system when Drone delivery status is At home, Operating system version is Update required. [H-7]

Description:

SC-32: DDS must provide Update drone system when Drone delivery status is At home, Operating system version is Update required.

Recommendation 33: (Controller: Distribution center - Control Action: Request a flight plan)

UCA-33: Distribution center not provided Request a flight plan in any context. [H-7]

Description:

SC-33: Distribution center must provide Request a flight plan in any context.

Recommendation 34: (Controller: Distribution center - Control Action: Cancel a flight)

UCA-34: Distribution center not provided Cancel a flight when Request status is Accepted. [H-1]

Description:

SC-34: Distribution center must provide Cancel a flight when Request status is Accepted.

Recommendation 35: (Controller: Drone - Control Action: Release package)

UCA-35: Drone provided Release package when Drone delivery status is Emergency landing. [H-1]

Description:

SC-35: Drone must not provide Release package when Drone delivery status is Emergency landing.

Recommendation 36: (Controller: Drone - Control Action: Release package)

UCA-36: Drone provided Release package when Drone delivery status is Flying. [H-1]

Description:

SC-36: Drone must not provide Release package when Drone delivery status is Flying.

Recommendation 37: (Controller: Drone - Control Action: Release package)

UCA-37: Drone provided Release package when Ground distance is Unsafe to release the payload. [H-1]

Description:

SC-37: Drone must not provide Release package when Ground distance is Unsafe to release the payload.

Recommendation 38: (Controller: Drone - Control Action: Release package)

UCA-38: Drone provided Release package when QR code is Not identified. [H-1]

Description:

SC-38: Drone must not provide Release package when QR code is Not identified.

Recommendation 39: (Controller: Drone - Control Action: Release package)

UCA-39: Drone provided Release package when Customer QR code is Not identified. [H-1]

Description:

SC-39: Drone must not provide Release package when Customer QR code is Not identified.

Recommendation 40: (Controller: Drone - Control Action: Release package)

UCA-40: Drone provided Release package when Emergency situation is True. [H-1]

Description:

SC-40: Drone must not provide Release package when Emergency situation is True.

Recommendation 41: (Controller: Drone - Control Action: Release package)

UCA-41: Drone provided Release package when Drone position is Unidentified. [H-1]

Description:

SC-41: Drone must not provide Release package when Drone position is Unidentified.

Recommendation 42: (Controller: Drone - Control Action: Release package)

UCA-42: Drone not provided Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position. [H-7]

Description:

SC-42: Drone must provide Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position.

Recommendation 43: (Controller: Drone - Control Action: Release package)

UCA-43: Drone provided too late Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position. [H-7]

Description:

SC-43: Drone must not provide too late Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position.

Recommendation 44: (Controller: Drone - Control Action: Release package)

UCA-44: Drone stopped too soon Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position. [H-1][H-3][H-7]

Description:

SC-44: Drone must not provide too soon Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position.

Recommendation 45: (Controller: Drone - Control Action: Release package)

UCA-45: Drone applied too long Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position. [H-3]

Description:

SC-45: Drone must not provide too long Release package when Ground distance is Safe to release the payload, Customer QR code is Identified, Drone position is GPS position.

Recommendation 46: (Controller: Virtual store - Control Action: Request the period for delivery)

UCA-46: Virtual store not provided Request the period for delivery in any context. [H-7]

Description:

SC-46: Virtual store must provide Request the period for delivery in any context.

Step Four - Loss Scenarios and Recommendations

R-1 (Virtual store -> Customer): UCA-1

Type:

Cause: The Customer did not receive the feedback from Virtual store to Customer (Request status, Delivery status or List of periods) is missing.

Recommendation: The communication from Virtual store to Customer must be improved by using a communication protocol that ensures the delivery in a fast way.

Mechanism: Use communication protocols that ensure the communication.

R-2 (Customer -> Virtual store): UCA-1

Type:

Cause: Customer does not provide (missing) the control action: Request the period for delivery; to Virtual store.

Recommendation: The communication of Customer to Virtual store must be improved by using reliable protocol to send the control actions.

Mechanism: Use reliable protocol and JSON file format.

R-3 (Virtual store Algorithm/Logic in Virtual store): UCA-46

Type:

Cause: An incorrect Virtual store Algorithm/Logic was designed which is not able to provide the control action.

Recommendation: The Virtual store Algorithm/Logic must be revised AND tested when updated to send the control action immediately to the Device center. Virtual store algorithm must also be projected to operate in specific hardware.

Mechanism: Reliable operating system, fast processor, fast link, and enough RAM memory.

R-4 (Distribution center -> Virtual store): UCA-46

Type:

Cause: Feedback from Distribution center to Virtual store is delayed or missing.

Recommendation: The feedback from Distribution center to Virtual store must have alternative link or use a protocol that ensure the communication.

Mechanism: Use a reliable and fast protocol.

R-5 (Virtual store -> Distribution center): UCA-46

Type:

Cause: Virtual store does not provide (missing) the control action: Request the period for delivery; to Distribution center.

Recommendation: The communication of Virtual store to Distribution center must be improved by having an alternative and reliable link.

Mechanism: Virtual store must have an alternative link to communicate with distribution center.

R-6 (Customer Algorithm/Logic in Customer): UCA-1

Type:

Cause: An incorrect Customer Algorithm/Logic was designed. The customer requested a period that is not possible to accomplish the delivery and did not choose a new period from the received a list of available periods to accomplish the delivery.

Recommendation: When the customer receives a list of available periods, the customer must be informed about the need to select a new period. The Customer Logic must be revised AND trained when updated.

Mechanism: Message explaining the status of delivery.

R-7 (Distribution center Algorithm/Logic in Distribution center): UCA-33

Type:

Cause: An incorrect Distribution center Algorithm/Logic was designed, and the Distribution center did not request or delay the request for a flight plan.

Recommendation: The Distribution center Algorithm/Logic must be revised AND tested when updated to provide the request on time.

Mechanism: The Distribution center application must run in Linux system.

R-8 (DDS -> Distribution center): UCA-33

Type:

Cause: Feedback from DDS to Distribution center (Request status, Delivery status or List of periods) is missing, and the Distribution center did not receive or received delayed the flight plan approved or denied.

Recommendation: The communication from DDS to Distribution center must be improved and have a reliable link for feedback.

Mechanism: Distribution center must have an alternative internet link.

R-9 (Distribution center -> Distribution center): UCA-33

Type:

Cause: The Distribution center does not perform its functions to communicate with DDS after software update.

Recommendation: The Distribution center must have ongoing analysis after system modification, and be projected to operate in specific hardware.

Mechanism: RAM memory with 8 GB or higher, reliable link connection, and fast processor.

R-10 (Distribution center -> DDS): UCA-33

Type:

Cause: Distribution center issued an incorrect (inappropriate) control action: Request a flight plan to DDS. The control action becomes inappropriate or ineffective after DDS updates.

Recommendation: The process model in Distribution center must represent the Delivery process and DDS and be updated after each interaction with DDS.

Mechanism: The distribution center must use a centralized database.

R-11 (Distribution center -> DDS): UCA-33

Type:

Cause: DDS does not provide the received control action (Request a flight plan) from Distribution center. The DDS updates the system and did not accept the old style requisitions.

Recommendation: Distribution center must have ongoing analysis after system modification and use a standardized pattern to send control actions.

Mechanism: The system must use JSON pattern.

R-12 (Distribution center -> DDS): UCA-33

Type:

Cause: Distribution center does not provide (missing) the control action: Request a flight plan to DDS.

Recommendation: The communication of Distribution center to DDS must be projected to operate in specific hardware.

Mechanism: Fast processor and reliable hardware.

R-13 (DDS Algorithm/Logic in DDS): UCA-5

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be projected for a specific hardware AND revised AND tested when updated.

Mechanism: Application and operating system with real-time answers.

R-14 (DDS -> DDS): UCA-5

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS must have ongoing analysis after system modification. The system must have also a replication.

Mechanism: The application must support replication.

R-15 (DDS -> Drone): UCA-5

Type:

Cause: DDS does not provide (missing) the control action: Start flight to Drone.

Recommendation: The communication of DDS to Drone must be improved by using protocols that ensure the control action delivery.

Mechanism: The application protocol is HTTP and network must be 4G or higher.

R-16 (Drone -> DDS): UCA-5

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication from Drone to DDS must be improved by using protocols that ensure the message delivery.

Mechanism: The application protocol is HTTP and network layer protocol is 4G or higher.

R-17 (DDS Algorithm/Logic in DDS): UCA-6

Type:

Cause: DDS Algorithm/Logic updated incorrectly.

Recommendation: The DDS Algorithm/Logic must be revised AND tested when updated to never provide start flight when flight plan status is denied.

Mechanism:

R-18 (DDS Process Model in DDS): UCA-5

Type:

Cause: Current state of DDS Process Model is wrong due to the delay to process the Drone feedback. The process model was not updated with current informations.

Recommendation: The process model must be stored in RAM memory during its use.

Mechanism: More processor, more RAM memory, reliable link and more link speed.

R-19 (DDS -> DDS): UCA-6

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS must support replication and have ongoing analysis after system modification.

Mechanism: Use replication.

R-20 (DDS Algorithm/Logic in DDS): UCA-7

Type:

Cause: DDS Algorithm/Logic updated incorrectly.

Recommendation: The DDS Algorithm/Logic must be revised AND never provide Start flight when Flight cancelled is True.

Mechanism:

R-21 (DDS -> Drone): UCA-7

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Start flight to Drone.

Recommendation: The process model in DDS must represent the Delivery process and Drone.

Mechanism:

R-22 (DDS -> DDS): UCA-5

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS must be projected to operate in specific hardware and have ongoing analysis after system modification.

Mechanism: Scalable system.

R-23 (DDS Algorithm/Logic in DDS): UCA-8

Type:

Cause: DDS Algorithm/Logic updated incorrectly.

Recommendation: The DDS Algorithm/Logic must be projected for a specific hardware, be revised AND tested when updated.

Mechanism:

R-24 (DDS Process Model in DDS): UCA-8

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The process model of DDS must have periodical feedbacks from Drone.

Mechanism:

R-25 (Drone -> DDS): UCA-8

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication from Drone to DDS must be improved.

Mechanism: HTTP and 4G connection.

R-26 (DDS -> Drone): UCA-8

Type:

Cause: DDS issued an conflicting control action: Start flight to Drone.

Recommendation: The process model in DDS must receive periodical feedbacks from Drone.

Mechanism:

R-27 (DDS -> Drone): UCA-8

Type:

Cause: DDS issued an conflicting control action: Start flight to Drone.

Recommendation: The process model in DDS must receive periodical feedbacks from Drone.

Mechanism:

R-28 (DDS -> Drone): UCA-8

Type:

Cause: DDS issued an conflicting control action: Start flight to Drone.

Recommendation: The DDS must never provide Start flight when Drone battery is low.

Mechanism:

R-29 (DDS Algorithm/Logic in DDS): UCA-9

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be projected for a specific hardware, revised AND tested when updated.

Mechanism:

R-30 (DDS Algorithm/Logic in DDS): UCA-9

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS must neve start flight when Weather is inappropriate for flight.

Mechanism:

R-31 (Weather system -> DDS): UCA-9

Type:

Cause: Weather system is wrong. The DDS receive a different pattern of information from External system.

Recommendation: The communication of the external system to DDS must have a standardized pattern for external information.

Mechanism:

R-32 (Weather system -> DDS): UCA-9

Type:

Cause: Weather system is missing.

Recommendation: The communication link of the external system to DDS must be improved.

Mechanism: Use a reliable link for external systems.

R-33 (DDS -> Drone): UCA-9

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Start flight to Drone.

Recommendation: The process model in DDS must never start a flight when Wheater information is Inappropriate for flight.

Mechanism:

R-34 (DDS Algorithm/Logic in DDS): UCA-10

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be projected for a specific hardware, revised AND tested when updated.

Mechanism:

R-35 (Drone -> DDS): UCA-10

Type:

Cause: Feedback from Drone to DDS (Emergency situation) is missing.

Recommendation: The communication from Drone to DDS must be improved o a fast and reliable link.

Mechanism: Use 4G connection

R-36 (DDS -> Drone): UCA-10

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Start flight to Drone.

Recommendation: The process model in DDS must and never start a flight when Drone emergency is True.

Mechanism:

R-37 (Drone -> DDS): UCA-10

Type:

Cause: Feedback from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative link.

Mechanism:

R-38 (DDS Process Model in DDS): UCA-11

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The process model of DDS must be periodically updated.

Mechanism:

R-39 (Drone -> DDS): UCA-11

Type:

Cause: Feedback from Drone to DDS (Delivery status) is wrong.

Recommendation: The communication from Drone to DDS must use a standardized pattern to send feedback.

Mechanism: Use the JSON pattern.

R-40 (DDS -> Drone): UCA-11

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Start flight to Drone.

Recommendation: The process model in DDS must provide the control action in time.

Mechanism:

R-41 (DDS Algorithm/Logic in DDS): UCA-11

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must use low complexity, be revised AND tested when updated.

Mechanism:

R-42 (DDS Algorithm/Logic in DDS): UCA-12

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be revised AND tested to provide the control action on time.

Mechanism: DDS application must run on Virtual Machine.

R-43 (DDS Algorithm/Logic in DDS): UCA-12

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must have low time complexity to provide Start flight on the right time.

Mechanism: The application must run on Virtual Machine.

R-44 (DDS -> DDS): UCA-12

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS must have hardware requirements to normal operation and ongoing analysis after system modification.

Mechanism: Fast processor, RAM memory, and fast connection.

R-45 (DDS -> Drone): UCA-12

Type:

Cause: DDS delays to provide the control action: Start flight to Drone.

Recommendation: The communication link of DDS to Drone must be improved and the DDS algorithm must have low time complexity.

Mechanism: Fast and reliable connection.

R-46 (DDS Algorithm/Logic in DDS): UCA-13

Type:

Cause: DDS Algorithm/Logic ineffective after process changes.

Recommendation: The DDS Algorithm/Logic must be updated AND revised AND tested. The DDS Algorithm must be tested on emulator and real drone before be approved.

Mechanism: Application must support scalability.

R-47 (DDS Process Model in DDS): UCA-13

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The process model of DDS must represent the Delivery process and Drone, and improve the communication between DDS and Drone.

Mechanism: Replication of the application.

R-48 (Weather system -> DDS): UCA-13

Type:

Cause: Weather system is missing.

Recommendation: The communication of the external system to DDS must be improved. DDS must have a fast connection and be able to process the Weather information.

Mechanism: Fast link and fast processor.

R-49 (DDS -> DDS): UCA-13

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: DDS algorithm must be projected to operate in specific hardware and have ongoing analysis after system modification.

Mechanism: Fast processor, and RAM memory with less than 60% of use.

R-50 (DDS -> Drone): UCA-13

Type:

Cause: DDS does not provide (missing) the control action: Back to home to Drone.

Recommendation: The communication of DDS to Drone must be improved and have a dedicated instance of the application to communicate with drone.

Mechanism: Fast internet connection and dedicated application.

R-51 (DDS Algorithm/Logic in DDS): UCA-14

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be revised AND tested when updated. The test must include several hours in drone emulator.

Mechanism:

R-52 (DDS -> Drone): UCA-14

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: The process model in DDS must never provide Back to home when Flight plan status is Denied.

Mechanism:

R-53 (DDS Algorithm/Logic in DDS): UCA-15

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must use low complexity be revised AND tested when updated.

Mechanism:

R-54 (DDS -> Drone): UCA-15

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: The process model in DDS must have periodical feedbacks from Drone.

Mechanism:

R-55 (DDS Algorithm/Logic in DDS): UCA-16

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must low complexity, be revised AND tested when updated.

Mechanism:

R-56 (DDS Algorithm/Logic in DDS): UCA-16

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The drone must never flight when Drone battery is Low battery.

Mechanism:

R-57 (DDS Process Model in DDS): UCA-16

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The process model of DDS must receive periodical feedbacks of Drone and external information.

Mechanism:

R-58 (Drone -> DDS): UCA-16

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The link realibility from Drone to DDS must be improved.

Mechanism:

R-59 (Drone -> DDS): UCA-16

Type:

Cause: Feedback from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative and fast link.

Mechanism:

R-60 (DDS -> Drone): UCA-16

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: DDS must never provide Back to Home when Drone battery is Low battery.

Mechanism:

R-61 (DDS Algorithm/Logic in DDS): UCA-17

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must have low complexity be revised AND tested when updated.

Mechanism:

R-62 (Weather system -> DDS): UCA-17

Type:

Cause: Weather system is wrong.

Recommendation: The DDS must implements the communication pattern of Weather System for external communication.

Mechanism:

R-63 (Weather system -> DDS): UCA-17

Type:

Cause: Weather system is missing.

Recommendation: The link reliability of the external system to DDS must be improved.

Mechanism:

R-64 (DDS -> Drone): UCA-17

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: Drone must never provide the control action Back to home when Weather information is Inappropriate for flight.

Mechanism:

R-65 (DDS Algorithm/Logic in DDS): UCA-18

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must use low complexity, be revised AND tested when updated.

Mechanism:

R-66 (DDS Process Model in DDS): UCA-18

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The DDS must receive periodical feedbacks.

Mechanism:

R-67 (Drone -> DDS): UCA-18

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The link reliability from Drone to DDS must be improved.

Mechanism:

R-68 (Drone -> DDS): UCA-18

Type:

Cause: Feedback from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative and fast link.

Mechanism:

R-69 (DDS -> Drone): UCA-18

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: DDS must never provide Back to Home when Emergency situation is True.

Mechanism:

R-70 (DDS Algorithm/Logic in DDS): UCA-19

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must be revised AND tested to provide the control action in the right time.

Mechanism:

R-71 (DDS Process Model in DDS): UCA-19

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The DDS must have the process model in RAM memory during its use.

Mechanism:

R-72 (Drone -> DDS): UCA-19

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication link from Drone to DDS must be reliable and fast.

Mechanism:

R-73 (Drone -> DDS): UCA-19

Type:

Cause: Feedback from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative link to send the feedback.

Mechanism:

R-74 (Weather system -> DDS): UCA-19

Type:

Cause: Weather system is missing.

Recommendation: The communication link of the external system to DDS must be reliable.

Mechanism:

R-75 (DDS -> Drone): UCA-19

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Back to home to Drone.

Recommendation: The DDS must have the process model stored in the RAM memory to provide the correct control action.

Mechanism:

R-76 (DDS Algorithm/Logic in DDS): UCA-20

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must have low space complexity, be revised AND tested when updated.

Mechanism: Fast processor and RAM memory.

R-77 (DDS -> Drone): UCA-20

Type:

Cause: DDS delays to provide the control action: Back to home to Drone.

Recommendation: The communication link of DDS to Drone must be improved and send only the information to controls the Drone.

Mechanism: Fast processor, RAM memory, reliable connection.

R-78 (DDS Algorithm/Logic in DDS): UCA-21

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must be projected to operate in specific hardware.

Mechanism: Fast processor, RAM memory, reliable and fast link connection.

R-79 (Drone -> DDS): UCA-21

Type:

Cause: Feedback from Drone to DDS (Drone delivery status) is missing.

Recommendation: The communication link from Drone to DDS must be fast.

Mechanism: Reliable link connection.

R-80 (Weather system -> DDS): UCA-21

Type:

Cause: Weather system is missing.

Recommendation: The communication link of the external system to DDS must have a fast connection. DDS must be able to process the Weather information.

Mechanism: Reliable link connection and fast processor.

R-81 (DDS -> DDS): UCA-21

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS must be projected to operate in specific hardware and have ongoing analysis after system modification.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-82 (DDS -> Drone): UCA-21

Type:

Cause: DDS does not provide (missing) the control action: Go to position to Drone.

Recommendation: DDS must have a dedicated instance of the application to communicate with drone and employ protocols that ensure the message delivery.

Mechanism: Scalable Virtual Machine, fast processor, RAM memory, fast connection, and HTTP protocol.

R-83 (DDS -> Drone): UCA-21

Type:

Cause: Drone does not provide the received control action (Go to position) from DDS.

Recommendation: The Drone must have ongoing analysis after system modification and DDS must send control actions that can be processed by Drone.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-84 (DDS Algorithm/Logic in DDS): UCA-22

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must have low complexity and be projected to operate in specific hardware.

Mechanism: Fast processor, RAM memory, reliable and fast link connection.

R-85 (DDS Process Model in DDS): UCA-22

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: DDS must have a reliable link and employ protocols that ensure the message delivery.

Mechanism: Reliable and dedicated link.

R-86 (Drone -> DDS): UCA-22

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication from Drone to DDS must be improved by using reliable link and employ fast protocols that ensure the message delivery.

Mechanism: Reliable link connection and HTTP protocol.

R-87 (Weather system -> DDS): UCA-22

Type:

Cause: Weather system is missing.

Recommendation: DDS must have a fast connection to receive the Weather information.

Mechanism: Fast link connection.

R-88 (DDS -> DDS): UCA-22

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: DDS algorithm must be projected to operate in specific hardware and employ protocols that ensure the message delivery.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-89 (DDS -> Drone): UCA-22

Type:

Cause: DDS does not provide (missing) the control action: Go to position to Drone.

Recommendation: DDS must have a dedicated instance of the application to communicate with drone and employ protocols that ensure the message delivery.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-90 (DDS -> Drone): UCA-22

Type:

Cause: Drone does not provide the received control action (Go to position) from DDS.

Recommendation: The Drone must have ongoing analysis after system modification and DDS must employ protocols that ensure the delivery.

Mechanism: Fast processor, RAM memory with less than 60%, fast connection, and Lorawan protocol.

R-91 (DDS Algorithm/Logic in DDS): UCA-23

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must be projected to operate in specific hardware and employ protocols that ensure the message delivery.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-92 (DDS Process Model in DDS): UCA-23

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: DDS must have be able to process the feedback to provide the right control actions, and use a reliable link.

Mechanism: Fast and reliable connection.

R-93 (Drone -> DDS): UCA-23

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication from Drone to DDS must use fast and reliable link, and employ protocols that guarantee the message delivery.

Mechanism: Reliable connection, fast connection, and HTTP protocol.

R-94 (DDS -> DDS): UCA-23

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: DDS algorithm must be projected to operate in specific hardware.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-95 (DDS -> Drone): UCA-23

Type:

Cause: DDS does not provide (missing) the control action: Go to position to Drone.

Recommendation: DDS must be able to process the feedback in time to provide the correct control actions and use reliable protocols.

Mechanism: Fast processor, fast connection, and HTTP protocol.

R-96 (DDS -> Drone): UCA-23

Type:

Cause: Drone does not provide the received control action (Go to position) from DDS.

Recommendation: The Drone must have ongoing analysis after system modification and DDS must send a standardized control actions.

Mechanism: Fast processor, RAM memory with less than 60%, fast connection, and Lorawan protocol.

R-97 (DDS Algorithm/Logic in DDS): UCA-24

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must employ protocols that ensure the message delivery and be projected to operate in specific hardware.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-98 (DDS Process Model in DDS): UCA-24

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: DDS must have a reliable link and be able to process the feedback to provide the right control actions.

Mechanism: Reliable connection and fast processor.

R-99 (Drone -> DDS): UCA-24

Type:

Cause: Feedback from Drone to DDS (Drone position, Emergency situation, Drone delivery status) is missing.

Recommendation: DDS must have a reliable link and use a standardized pattern to send control actions.

Mechanism: Reliable connection, fast connection, and HTTP protocol.

R-100 (DDS -> DDS): UCA-24

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: DDS algorithm must be projected to operate in specific hardware and use protocols that guarantee the message delivery.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-101 (DDS -> Drone): UCA-24

Type:

Cause: DDS does not provide (missing) the control action: Go to position; to Drone.

Recommendation: The communication of DDS to Drone must be improved. DDS algorithm must be projected to operate in specific hardware and use protocols that guarantee the message delivery.

Mechanism: Fast processor, RAM memory, HTTP protocol, and alternative link connection.

R-102 (DDS -> Drone): UCA-24

Type:

Cause: Drone does not provide the received control action (Go to position) from DDS.

Recommendation: DDS must use reliable protocol to send control actions to Drone.

Mechanism: HTTP protocol.

R-103 (DDS Algorithm/Logic in DDS): UCA-25

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must low complexity of time and space, be revised AND tested when updated.

Mechanism: Fast processor, RAM memory with less than 80%, fast connection, and Lorawan protocol.

R-104 (DDS Process Model in DDS): UCA-25

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The DDS must receive periodical feedbacks.

Mechanism:

R-105 (DDS Algorithm/Logic in DDS): UCA-26

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must have low space complexity, be revised AND tested.

Mechanism: Fast processor, RAM memory with less than 80%, fast connection, and Lorawan protocol.

R-106 (DDS Process Model in DDS): UCA-26

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The DDS must have the process model in the RAM memory during its use.

Mechanism:

R-107 (Weather system -> DDS): UCA-26

Type:

Cause: Weather system is missing or delayed.

Recommendation: The communication link of the external system to DDS must be reliable and fast.

Mechanism: Fast and reliable connection.

R-108 (DDS -> Drone): UCA-26

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Go to position to Drone.

Recommendation: The DDS must have the process model stored in RAM memory and use protocols that ensure the control action delivery.

Mechanism: Fast processor, RAM memory with less than 80%, fast connection, and Lorawan protocol.

R-109 (DDS -> Drone): UCA-25

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Go to position to Drone.

Recommendation: The DDS must have several instances of the application that controls the drones. Each instance must use reliable protocols to send control actions.

Mechanism: Fast processor, RAM memory with less than 80%, fast connection, and Lorawan protocol.

R-110 (DDS Algorithm/Logic in DDS): UCA-2

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must be tested with emulator and real drones before be implemented.

Mechanism: Use Virtual Machine to run application

R-111 (Drone -> DDS): UCA-2

Type:

Cause: Feedback from Drone to DDS (Drone position) is missing. DDS believes that the Drone is returning of a delivery.

Recommendation: The communication from Drone to DDS must be improved. DDS algorithm must employs protocols that ensure the message delivery.

Mechanism: HTTP protocol.

R-112 (DDS Algorithm/Logic in DDS): UCA-3

Type:

Cause: DDS Algorithm/Logic ineffective after process changes.

Recommendation: The algorithm must respect the standardized pattern to communicate with USS.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-113 (Drone -> DDS): UCA-3

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The link reliability from Drone to DDS must have an alternative link for internet connection.

Mechanism: Alternative link for internet connection.

R-114 (Drone -> DDS): UCA-3

Type:

Cause: Feedback (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative and fast link connection.

Mechanism: Fast processor, fast and alternative link for internet connection.

R-115 (DDS Algorithm/Logic in DDS): UCA-4

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must have low complexity, be revised AND tested.

Mechanism:

R-116 (DDS Process Model in DDS): UCA-4

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: The DDS must have the process model in the RAM memory during its use.

Mechanism:

R-117 (Drone -> DDS): UCA-4

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The link reliability from Drone to DDS must be improved or have an alternative link.

Mechanism:

R-118 (Drone -> DDS): UCA-4

Type:

Cause: Feedback (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) from Drone to DDS is delayed.

Recommendation: The feedback from Drone to DDS must have alternative and fast communication link.

Mechanism:

R-119 (Drone Algorithm/Logic in Drone): UCA-35

Type:

Cause: Drone Algorithm/Logic ineffective after process changes.

Recommendation: Drone must never release the package in an emergency landing.

Mechanism:

R-120 (Package sensor -> Drone): UCA-35

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor. Drone believes that packagem is delivered.

Recommendation: The Package sensor shall have alternative way to read the package.

Mechanism:

R-121 (Drone -> Compartment actuator): UCA-35

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance.

Mechanism:

R-122 (Drone -> Compartment actuator): UCA-35

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: The Drone must enforce the communication between drone and sensor.

Mechanism:

R-123 (Drone -> Compartment actuator): UCA-35

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: Drone must never provides the Release package during the Emergency landing.

Mechanism:

R-124 (Drone Algorithm/Logic in Drone): UCA-36

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must be revised AND tested in different scenarios and several times when updated.

Mechanism:

R-125 (Package sensor -> Drone): UCA-36

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process or the communication must be improved.

Mechanism:

R-126 (Drone Algorithm/Logic in Drone): UCA-37

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must be revised AND tested in different scenarios and several times when updated.

Mechanism:

R-127 (Package sensor -> Drone): UCA-37

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process and the package.

Mechanism:

R-128 (Drone Algorithm/Logic in Drone): UCA-38

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must have low complexity of time and space, be revised AND tested.

Mechanism:

R-129 (Package sensor -> Drone): UCA-38

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process.

Mechanism:

R-130 (Drone Algorithm/Logic in Drone): UCA-39

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must have low complexity.

Mechanism:

R-131 (Package sensor -> Drone): UCA-39

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process.

Mechanism:

R-132 (Drone Algorithm/Logic in Drone): UCA-40

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must have low space complexity.

Mechanism:

R-133 (Package sensor -> Drone): UCA-40

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process.

Mechanism:

R-134 (Drone Algorithm/Logic in Drone): UCA-41

Type:

Cause: An incorrect Drone Algorithm/Logic was designed.

Recommendation: The Drone Algorithm/Logic must have low time complexity.

Mechanism:

R-135 (Package sensor -> Drone): UCA-41

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Package sensor.

Recommendation: The Package sensor shall have alternative way to read Delivery process.

Mechanism:

R-136 (Drone -> Compartment actuator): UCA-36

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance (every month).

Mechanism:

R-137 (Drone -> Compartment actuator): UCA-36

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package.

Recommendation: The process model of Drone must be in the RAM memory during its use.

Mechanism:

R-138 (Drone -> Compartment actuator): UCA-36

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package.

Recommendation: Drone must only provide Open compartment during the hovering phase and distance is safe to release the package.

Mechanism:

R-139 (Distance sensor -> Drone): UCA-37

Type:

Cause: Current state of the Delivery process cannot be read accurately by Distance sensor.

Recommendation: The Distance sensor must have accuracy == 5cm.

Mechanism:

R-140 (Distance sensor -> Drone): UCA-37

Type:

Cause: Delivery process cannot be read (failure) by the Distance sensor.

Recommendation: The Distance sensor must be maintained when time of use == 3 months.

Mechanism:

R-141 (Drone -> Compartment actuator): UCA-37

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance every month.

Mechanism:

R-142 (Drone -> Compartment actuator): UCA-37

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: The process model must be in the RAM memory during its use.

Mechanism:

R-143 (Drone -> Compartment actuator): UCA-37

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: Drone must only release the package when the Ground distance is safe to release.

Mechanism:

R-144 (Camera -> Drone): UCA-38

Type:

Cause: Current state of the Delivery process cannot be read accurately by Camera.

Recommendation: The Camera must have accept only QR code pattern.

Mechanism:

R-145 (Drone -> Compartment actuator): UCA-38

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have every month maintenance.

Mechanism:

R-146 (Drone -> Compartment actuator): UCA-38

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: The process model be updated in real-time.

Mechanism:

R-147 (Drone -> Compartment actuator): UCA-38

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: Drone must provide Open compartment only if the QR code is identified.

Mechanism:

R-148 (Delivery process Environmental_disturbances -> Delivery process): UCA-39

Type:

Cause: Delivery process affected by natural or man made disasters and made Drone provides the Release package.

Recommendation: The Delivery process must be resistant to disasters.

Mechanism:

R-149 (Drone -> Compartment actuator): UCA-39

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance.

Mechanism:

R-150 (Drone -> Compartment actuator): UCA-39

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package.

Recommendation: The process model must be in the RAM memory during its use.

Mechanism:

R-151 (Drone -> Compartment actuator): UCA-39

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package.

Recommendation: Drone must provide Open compartment only if the QR code is Customer identified.

Mechanism:

R-152 (Drone -> Compartment actuator): UCA-40

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance.

Mechanism:

R-153 (Drone -> Compartment actuator): UCA-40

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package.

Recommendation: The process model must be in the RAM memory during its use.

Mechanism:

R-154 (Drone -> Compartment actuator): UCA-40

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: Drone must never provide the Release package when Emergency situation is True.

Mechanism:

R-155 (Drone -> Compartment actuator): UCA-41

Type:

Cause: Compartment actuator performs (executed) a non-issued control action.

Recommendation: The Compartment actuator must be reliable and have maintenance every month.

Mechanism:

R-156 (Drone -> Compartment actuator): UCA-41

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: The process model must be in the RAM memory during its use.

Mechanism:

R-157 (Drone -> Compartment actuator): UCA-41

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: Drone must never release the package when position is undefined.

Mechanism:

R-158 (Drone Algorithm/Logic in Drone): UCA-42

Type:

Cause: An incorrect Drone operating system was designed.

Recommendation: The Drone operating system must be revised and tested using the emulator several times and with different scenarios when updated.

Mechanism: RTOS operating system, fast processor, and free RAM memory.

R-159 (Drone Process Model in Drone): UCA-42

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: The process model of Drone must be in the RAM memory during its use.

Mechanism: RTOS operating system, fast processor, free RAM memory, and fast communication protocol.

R-160 (Distance sensor -> Drone): UCA-42

Type:

Cause: Current state of the Delivery process cannot be read accurately by Distance sensor.

Recommendation: The Distance sensor must have accuracy == 5cm.

Mechanism: Fast processor.

R-161 (Distance sensor -> Drone): UCA-42

Type:

Cause: Feedback of Distance sensor is missing.

Recommendation: The Distance sensor must be maintained when time of use == 3 months.

Mechanism: Fast processor and free memory.

R-162 (Cellular network positioning -> Drone): UCA-42

Type:

Cause: Cellular network positioning is wrong or missing.

Recommendation: The communication of the external system to Drone must be improved by using the GPS and cellphone network connection.

Mechanism: GPS and Cellphone network connection.

R-163 (GPS positioning -> Drone): UCA-42

Type:

Cause: GPS positioning is wrong or missing.

Recommendation: The communication of the external system to Drone must be improved by using the GPS combined with cellphone network connection.

Mechanism: A-GPS.

R-164 (Drone -> Compartment actuator): UCA-42

Type:

Cause: Compartment actuator did not received the control action, from Drone, or cannot act (not executed) in Delivery process.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance (each month).

Mechanism: RTOS operating system, fast processor, free RAM memory, and fast communication protocol.

R-165 (Drone -> Drone): UCA-42

Type:

Cause: The Drone controller does not perform its functions to send control actions and receive feedback.

Recommendation: Drone must be projected with a minimu hardware requirements, have a hundred hours of emulator test and a hundred hours of normal test.

Mechanism: RTOS operating system, processor, free RAM memory, and fast communication protocol.

R-166 (Drone -> Compartment actuator): UCA-42

Type:

Cause: Drone does not provide (missing) control action: Release package to Compartment actuator.

Recommendation: Drone system must be projected to operate in a specific hardware.

Mechanism: RTOS operating system, fast processor, fast communication protocol, and fast storage.

R-167 (Drone Algorithm/Logic in Drone): UCA-43

Type:

Cause: Drone Algorithm/Logic became ineffective after process changes.

Recommendation: DDS must use a real-time operating system that has efficient task scheduling and memory management. DDS must use a processor compatible with the real-time operating system.

Mechanism: The chosen RTOS operating system is RTOS4Drone. The processor is P4Drone which has a processor speed 1.0GHz and memory size of 512MB.

R-168 (Camera -> Drone): UCA-43

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Camera.

Recommendation: The Camera shall have alternative way to read the QR-Code of customer.

Mechanism: Fast processor and RTOS4Drone operating system.

R-169 (Camera -> Drone): UCA-43

Type:

Cause: Feedback of Camera is missing.

Recommendation: The Camera must be maintained when time of use == 1 week.

Mechanism: RAM memory and storage.

R-170 (Distance sensor -> Drone): UCA-43

Type:

Cause: Temporary obstruction does not allow the reading of the Delivery process by Distance sensor.

Recommendation: The Distance sensor shall have alternative way to read Delivery process, and must be maintained weekly.

Mechanism: Alternative sensor.

R-171 (Distance sensor -> Drone): UCA-43

Type:

Cause: Feedback of Distance sensor is missing.

Recommendation: The Distance sensor must be maintained when time of use == 1 month.

Mechanism: Free RAM memory and free storage memory.

R-172 (Cellular network positioning -> Drone): UCA-43

Type:

Cause: Cellular network positioning is missing.

Recommendation: The communication of the external system to Drone must be improved by using an alternative way to connect with cellphone network.

Mechanism: Alternative cellphone connection.

R-173 (GPS positioning -> Drone): UCA-43

Type:

Cause: GPS positioning is not accurate.

Recommendation: Drone must use reliable GPS systems to improve location accuracy, such as BeiDou and Galileo GPS.

Mechanism: GPS compatible with BeiDou and Galileo GPS and use the A-GPS positioning.

R-174 (Drone -> Compartment actuator): UCA-43

Type:

Cause: The issued control action delays to be enforced by the Compartment actuator.

Recommendation: The Compartment actuator must be reliable and have periodic maintenance (each month).

Mechanism: RTOS operating system, fast processor, and free memory.

R-175 (Package sensor -> Drone): UCA-44

Type:

Cause: Feedback of Package sensor is missing (missing).

Recommendation: The Package sensor must be maintained when time of use == 3 months.

Mechanism:

R-176 (Distance sensor -> Drone): UCA-44

Type:

Cause: Current state of the Delivery process cannot be read accurately by Distance sensor.

Recommendation: The Distance sensor must have accuracy == 5cm.

Mechanism:

R-177 (Drone -> Drone): UCA-44

Type:

Cause: The Drone does not perform its functions to send control actions and receive feedback.

Recommendation: The Drone must have periodical tests to ensure the well working of components.

Mechanism:

R-178 (Drone -> Compartment actuator): UCA-44

Type:

Cause: The Compartment actuator does not perform its functions to perform the control action.

Recommendation: The Compartment actuator must be tested after after system update.

Mechanism:

R-179 (Drone -> Compartment actuator): UCA-44

Type:

Cause: Drone issued an incorrect (inappropriate) control action: Release package to Compartment actuator.

Recommendation: The process model in Drone must be in the RAM memory during the Drone operation.

Mechanism:

R-180 (Package sensor -> Drone): UCA-44

Type:

Cause: Current state of the Delivery process cannot be read accurately by Package sensor.

Recommendation: The Package sensor must have an alternative sensor to identify when the box is released.

Mechanism:

R-181 (Package sensor -> Drone): UCA-45

Type:

Cause: Feedback (Package status) lost or corrupted.

Recommendation: The Package sensor of Drone must have a reliable sensor or alternative sensor.

Mechanism: Fast processor, RTOS operating system, and alternative or reliable sensor.

R-182 (Drone -> Compartment actuator): UCA-45

Type:

Cause: The Compartment actuator does not perform its functions to perform the control action.

Recommendation: The Compartment actuator must have ongoing analysis after system modification and have several hours of testing in the emulator and using a real drone.

Mechanism: Fast processor and RTOS operating system.

R-183 (Customer -> Virtual store): UCA-1

Type:

Cause: Virtual store does not provide the received control action (Request the period for delivery) from Customer.

Recommendation: The Virtual store must have ongoing analysis after system modification and use a standardized pattern for send control actions to Virtual store.

Mechanism: Use the JSON file format as a communication standard.

R-184 (Virtual store -> Distribution center): UCA-46

Type:

Cause: Distribution center does not provide the received control action (Request the period for delivery) from Virtual store.

Recommendation: The Distribution center must have ongoing analysis after system modification and employ standardized pattern for send control actions.

Mechanism: Use a JSON file pattern.

R-185 (Distribution center Algorithm/Logic in Distribution center): UCA-34

Type:

Cause: An incorrect Distribution center Algorithm/Logic was designed.

Recommendation: The Distribution center Algorithm/Logic must be revised AND tested when updated. Distribution center algorithm must be projected to operate in a reliable operating system.

Mechanism: The application must support Linux based systems.

R-186 (DDS -> Distribution center): UCA-34

Type:

Cause: Feedback from DDS to Distribution center (Request status, Delivery status or List of periods) is missing.

Recommendation: The communication from DDS to Distribution center must be improved or use a protocol that ensure the communication.

Mechanism: Use protocol that ensure the feedback delivery.

R-187 (Distribution center -> Distribution center): UCA-34

Type:

Cause: The Distribution center does not perform its functions to send control actions and receive feedback.

Recommendation: The Distribution center must have ongoing analysis after system modification and have replication to attend the demands.

Mechanism: Use VM to increase the requisitions attendance.

R-188 (Distribution center -> DDS): UCA-34

Type:

Cause: Distribution center issued an incorrect (inappropriate) control action: Cancel a flight to DDS. The control action becomes ineffective after DDS updates.

Recommendation: Distribution center algorithm must employ a file pattern to send control action and receive feedback.

Mechanism: Use JSON file format.

R-189 (Distribution center -> DDS): UCA-34

Type:

Cause: Distribution center does not provide (missing) the control action: Cancel a flight to DDS.

Recommendation: The communication of Distribution center to DDS must be improved by using reliable protocol for send control actions.

Mechanism: The protocol is HTTP.

R-190 (Distribution center -> DDS): UCA-34

Type:

Cause: DDS does not provide the received control action (Cancel a flight) from Distribution center.

Recommendation: The DDS must have ongoing analysis after system modification and the algorithm must have a standardized protocol for send control actions.

Mechanism: Use the JSON file format.

R-191 (DDS -> Drone): UCA-6

Type:

Cause: Drone does not provide the received control action (Start flight) from DDS.

Recommendation: The Drone must use reliable link to send the control action.

Mechanism: Enforce the link reliability and speed.

R-192 (DDS -> Drone): UCA-6

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Start flight to Drone.

Recommendation: The DDS must have a fast connection to send the control action to the Drone.

Mechanism: Enforce the link speed.

R-193 (DDS -> Drone): UCA-20

Type:

Cause: Drone delays to provide the received control action (Back to home) from DDS.

Recommendation: DDS must provide the control action in time and use a fast connection.

Mechanism: Reliable hardware and fast connection.

R-194 (DDS Process Model in DDS): UCA-21

Type:

Cause: Current state of DDS Process Model is wrong.

Recommendation: DDS must have a reliable link, be able to process the feedback in time and provide control actions.

Mechanism: Fast processor and reliable connection.

R-195 (Drone -> DDS): UCA-21

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is delayed or missing.

Recommendation: DDS algorithm must employ protocols that ensure the message delivery/receive.

Mechanism: Fast processor and reliable connection.

R-196 (Drone -> DDS): UCA-26

Type:

Cause: Feedback from Drone to DDS (Drone battery, Drone position, Emergency situation, Drone delivery status, Delivery status or Returning to base) is missing.

Recommendation: The communication link from Drone to DDS must be reliable.

Mechanism: Use 4G link.

R-197 (Drone Process Model in Drone): UCA-37

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: The process model must be updated in real-time.

Mechanism:

R-198 (Drone Process Model in Drone): UCA-38

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: The process model must be updated in real-time.

Mechanism:

R-199 (Drone Process Model in Drone): UCA-41

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: Use the Cellular network and GPS positioning for high accuracy.

Mechanism:

R-200 (Drone Process Model in Drone): UCA-43

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: The process model of Drone must be updated in real-time.

Mechanism: RTOS operating system, fast processor, and free RAM memory.

R-201 (Drone Process Model in Drone): UCA-44

Type:

Cause: Current state of Drone Process Model is wrong.

Recommendation: The process model of Drone must be updated in real-time.

Mechanism:

R-202 (DDS -> Drone): UCA-11

Type:

Cause: Drone does not provide the received control action (Start flight, Back to home or Go to position) from DDS.

Recommendation: The Drone must have ongoing analysis after system modification.

Mechanism:

R-203 (DDS -> Drone): UCA-21

Type:

Cause: DDS does not provide (missing) the control action: Go to position; to Drone.

Recommendation: DDS algorithm must be projected to operate in specific hardware and have a dedicated instance of the application to communicate with drone.

Mechanism: Use several instances of Virtual Machines.

R-204 (DDS -> Drone): UCA-22

Type:

Cause: DDS does not provide (missing) the control action: Go to position; to Drone.

Recommendation: DDS must have a dedicated instance of the application to communicate with drone.

Mechanism: Use several instances of Virtual Machines that runs the application.

R-205 (DDS -> Drone): UCA-23

Type:

Cause: DDS does not provide (missing) the control action: Go to position; to Drone.

Recommendation: DDS must have a dedicated instance of the application to send control actions to the Drone.

Mechanism: Use several instances of Virtual Machines.

R-206 (DDS -> Drone): UCA-24

Type:

Cause: DDS does not provide (missing) the control action: Go to position; to Drone.

Recommendation: DDS must have a dedicated instance of the application to provide control actions to Drone.

Mechanism: Use several instances of Virtual Machines.

R-207 (DDS Algorithm/Logic in DDS): UCA-27

Type:

Cause: DDS Algorithm/Logic ineffective after process changes.

Recommendation: DDS algorithm must run in a specific hardware configuration.

Mechanism: Fast processor, RAM memory and free storage.

R-208 (DDS -> DDS): UCA-27

Type:

Cause: The DDS does not perform its functions to send control actions and receive feedback.

Recommendation: The DDS hardware must support algorithm upgrades.

Mechanism: Fast processor, RAM memory, fast connection, and HTTP protocol.

R-209 (DDS -> Drone): UCA-5

Type:

Cause: Drone does not provide the received control action (Start flight) from DDS.

Recommendation: The Drone must employs protocols and standards that ensure the message delivery and have ongoing analysis after system modification.

Mechanism: JSON standard and ZigBee protocol.

R-210 (DDS -> Drone): UCA-12

Type:

Cause: Drone does not provide the received control action (Start flight) from DDS.

Recommendation: The Drone must be projected for a model of drone and have ongoing analysis after system modification.

Mechanism: Reliable communication protocol.

R-211 (DDS -> Drone): UCA-27

Type:

Cause: Drone does not provide the received control action (Go to position) from DDS.

Recommendation: Every control action must be tested with the emulator and with the real drone several times before be adopted.

Mechanism: Reliable communication protocol.

R-212 (DDS -> Drone): UCA-13

Type:

Cause: Drone does not provide the received control action (Back to home) from DDS.

Recommendation: DDS must use reliable protocol to communicate with Drone and have ongoing analysis after system modification.

Mechanism: JSON standard and ZigBee.

R-213 (DDS -> Drone): UCA-20

Type:

Cause: Drone does not provide the received control action (Back to home) from DDS.

Recommendation: Every control action must be tested on emulator and real drone several times before be adopted.

Mechanism: Realible communication protocol.

R-214 (DDS Algorithm/Logic in DDS): UCA-28

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must test the drone operating system in the emulator before provide the update all drones.

Mechanism: Bluetooth 4.0.

R-215 (Drone -> DDS): UCA-28

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: The communication link from Drone to DDS must work in low range connection.

Mechanism: Bluetooth 4.0.

R-216 (DDS -> Drone): UCA-28

Type:

Cause: DDS issued an incorrect (inappropriate) control action: Update drone system; to Drone.

Recommendation: DDS must certificate that Drone is at the base and stopped before start the operating system update.

Mechanism: Bluetooth 4.0.

R-217 (DDS Algorithm/Logic in DDS): UCA-29

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must verify the version of drone operating system before provide the update.

Mechanism: Bluetooth 4.0.

R-218 (DDS Algorithm/Logic in DDS): UCA-30

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must verify the version of drone operating system before provide the update.

Mechanism: Bluetooth 4.0.

R-219 (DDS Algorithm/Logic in DDS): UCA-31

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: The DDS Algorithm/Logic must verify the version of drone operating system before provide the update.

Mechanism: Bluetooth 4.0.

R-220 (Drone -> DDS): UCA-31

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: The communication link from Drone to DDS must be work in low range connection.

Mechanism: Bluetooth 4.0.

R-221 (Drone -> DDS): UCA-30

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: The communication from Drone to DDS must work in low range connection.

Mechanism: Bluetooth 4.0.

R-222 (Drone -> DDS): UCA-29

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: The communication link from Drone to DDS must work in low range connection.

Mechanism: Bluetooth 4.0.

R-223 (Drone -> DDS): UCA-29

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: DDS must certificate that Drone is at the base and stopped before start the update.

Mechanism: Bluetooth 4.0.

R-224 (Drone -> DDS): UCA-30

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: DDS must certificate that Drone is at the base and stopped before start the update.

Mechanism: Bluetooth 4.0.

R-225 (Drone -> DDS): UCA-31

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: DDS must certificate that Drone is at the base and stopped before start the update.

Mechanism: Bluetooth 4.0.

R-226 (DDS Algorithm/Logic in DDS): UCA-32

Type:

Cause: An incorrect DDS Algorithm/Logic was designed.

Recommendation: DDS algorithm must be tested on emulator and real drone before be approved.

Mechanism:

R-227 (Drone -> DDS): UCA-32

Type:

Cause: Feedback from Drone to DDS (Operating system version) is missing.

Recommendation: The communication link from Drone to DDS to update the operating system must work in low range.

Mechanism: Bluetooth 4.0.

R-228 (DDS -> Drone): UCA-32

Type:

Cause: DDS does not provide (missing) the control action: Update drone system; to Drone.

Recommendation: Drone must be in range of DDS bluetooth.

Mechanism: Bluetooth 4.0.

Link with energy

Compartment actuator -> Delivery process

Delivery process -> Package sensor

Delivery process -> Camera

Delivery process -> Distance sensor

Show control structure images

Error to load image