https://ntrs.nasa.gov/search.jsp?R=20190025161 2019-08-31T13:48:17+00:00Z

UTM TCL2 Software Design

Daniel Mulfinger

What is the UTM Software?

- Research Prototype Software
- Implements the UTM Concept of Operations
- Web Application
- Two pieces
  - UTM Core
  - Set of Services
- ~25K lines of code
- Agile-based with 4-week sprints

Design Principles

- Research prototype, but built with long-term view
- Use state-of-the art software design conventions
- Test-driven design (TDD)

Technologies Used

- Java

- Spring Framework

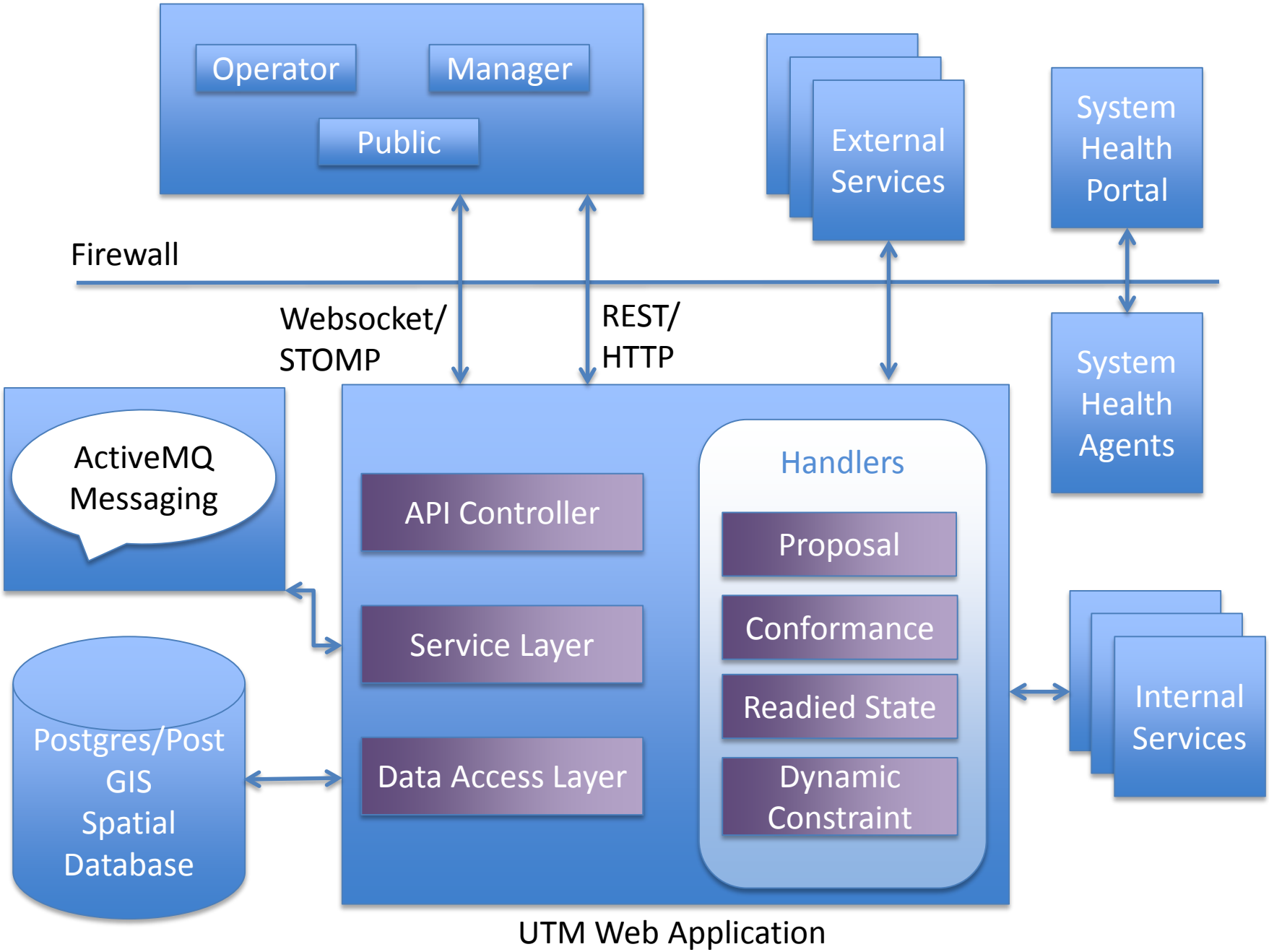
- Apache ActiveMQ

- Apache Tomcat
- STOMP

- PostgreSQL + PostGIS

- JTS Topology Suite
- REST (Representational State Transfer)
- Jenkins
- Atlassian

- SonarQube


Operator
Manager
Public
External Services
System Health Portal
Firewall
Websocket/ STOMP
REST/ HTTP
System Health Agents
ActiveMQ Messaging
API Controller
Service Layer
Data Access Layer
Handlers
Proposal
Conformance
Readied State
Dynamic Constraint
Internal Services
Postgres/Post GIS Spatial Database
UTM Web Application

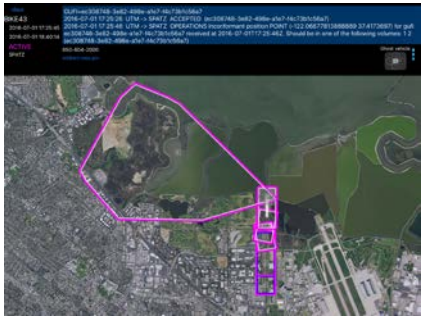
User Roles

- Operator
  - UAS operator
  - Submits/flies operations
- Manager
  - Sees complete picture
  - Can add manager constraints or override existing constraints
  - Can submit/close operations
  - Send messages to clients
- Public
  - Limited access

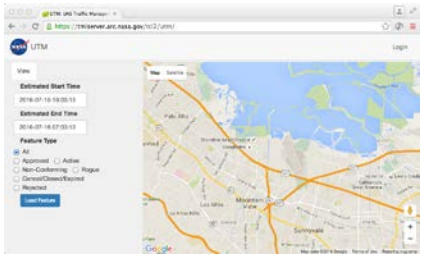
NASA Front-End Implementations

- Mission Planner compatible Python Client

- UTM Manager IOS App



- UTM Web Viewer

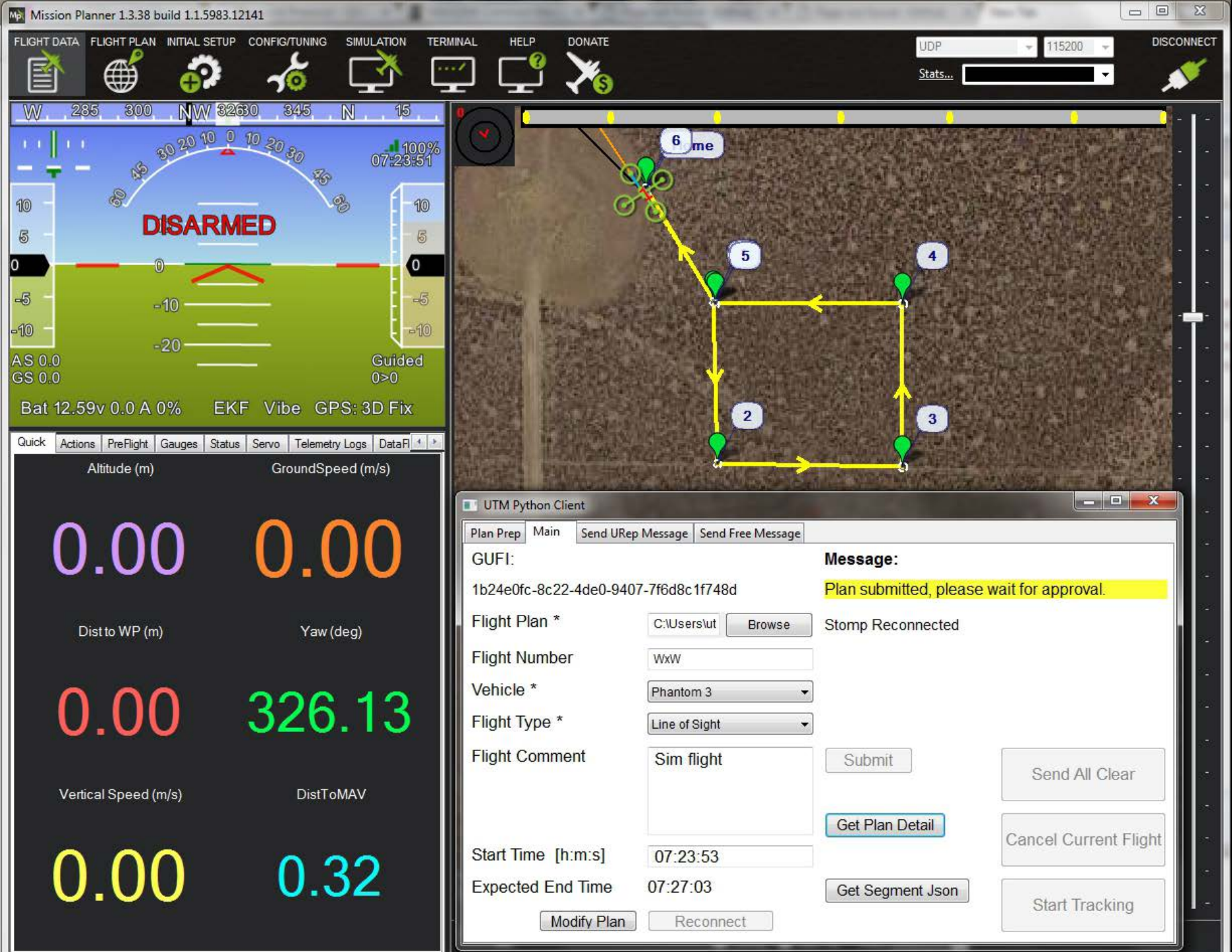


Software Demo

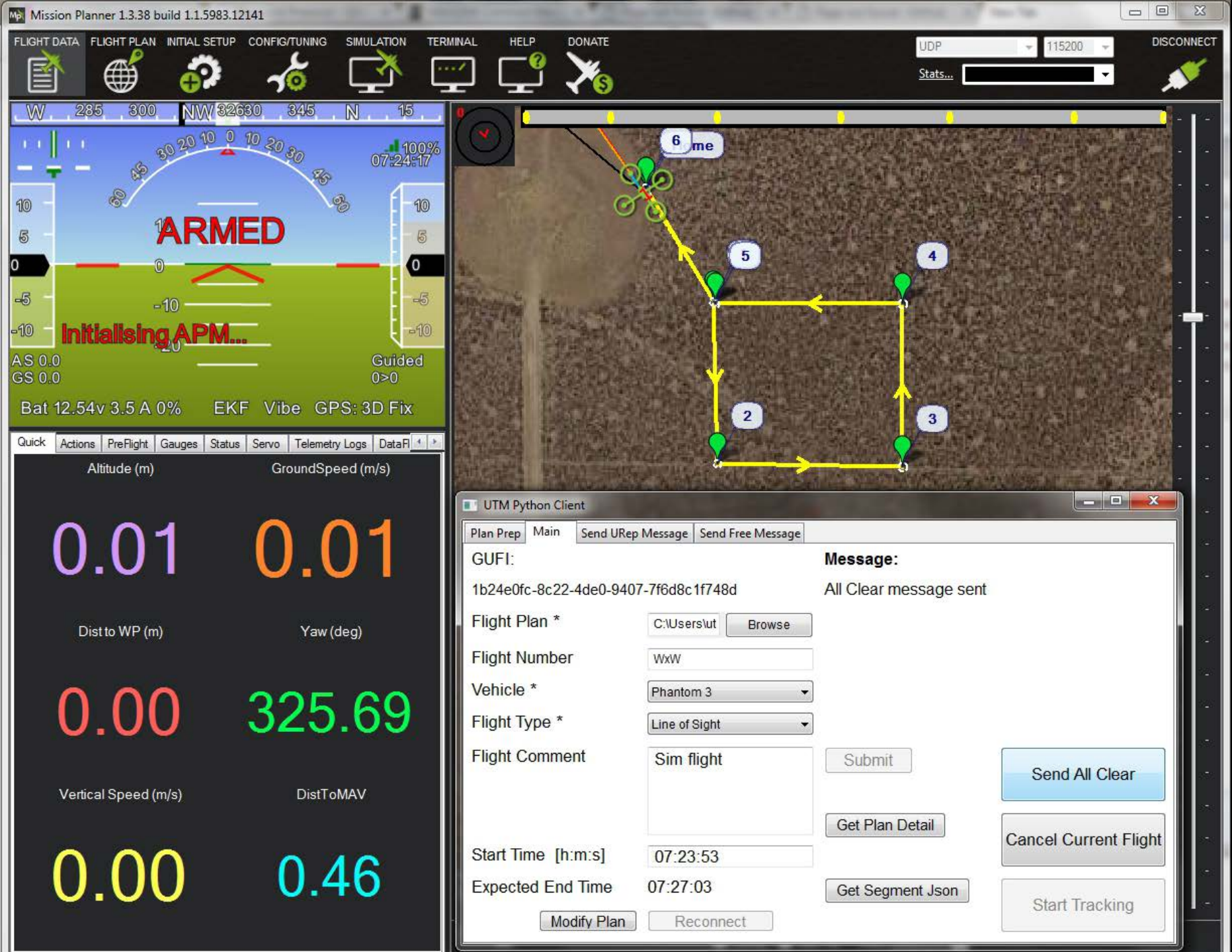
- Walk through screen shots
- (UTM Python Client w/iPad App)

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
DISARMED
100%
07:23:37
AS 0.0
GS 0.0
Guided
0>0
Bat 12.59v 0.0 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.00
0.00
Dist to WP (m)
Yaw (deg)
0.00
326.13
Vertical Speed (m/s)
DistToMAV
0.00
0.32
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
Message:
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Submit
Send All Clear
Get Plan Detail
Cancel Current Flight
Start Time [h:m:s]
Expected End Time
TBD
Get Segment Json
Start Tracking
Modify Plan
Stomp Connect

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
DISARMED
100%
07:23:43
AS 0.0
GS 0.0
Guided
0>0
Bat 12.59v 0.0 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.00
0.00
Dist to WP (m)
Yaw (deg)
0.00
326.13
Vertical Speed (m/s)
DistToMAV
0.00
0.32
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
Message:
Flight Plan *
C:\Users\ut
Browse
UTM: Stomp connection established
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Submit
Send All Clear
Get Plan Detail
Cancel Current Flight
Start Time [h:m:s]
Expected End Time
TBD
Get Segment Json
Start Tracking
Modify Plan
Reconnect

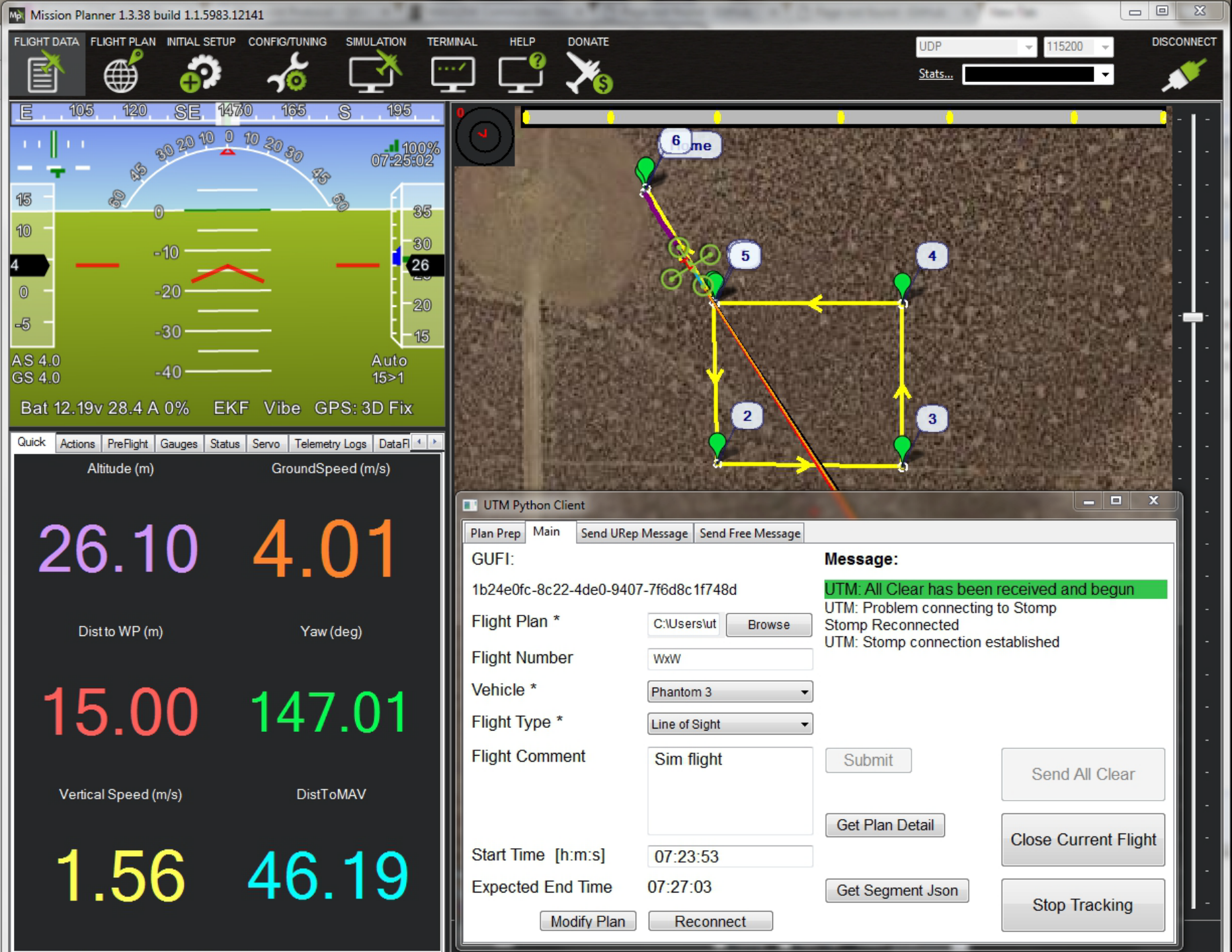

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
DISARMED
100%
07:23:51
AS 0.0
GS 0.0
Guided
0>0
Bat 12.59v 0.0 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.00
0.00
Dist to WP (m)
Yaw (deg)
0.00
326.13
Vertical Speed (m/s)
DistToMAV
0.00
0.32
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
Plan submitted, please wait for approval.
Stomp Reconnected
Submit
Get Plan Detail
Get Segment Json
Send All Clear
Cancel Current Flight
Start Tracking

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
ARMED
Initialising APM...
AS 0.0
GS 0.0
Guided
0>0
Bat 12.54v 3.5 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.00
0.01
Dist to WP (m)
Yaw (deg)
0.00
326.12
Vertical Speed (m/s)
DistToMAV
0.00
0.40
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: Plan has been Accepted.
Submit
Send All Clear
Get Plan Detail
Cancel Current Flight
Get Segment Json
Start Tracking


Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
ARMED
Initialising APM...
AS 0.0
GS 0.0
Guided
0>0
Bat 12.54v 3.5 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.01
0.01
Dist to WP (m)
Yaw (deg)
0.00
325.69
Vertical Speed (m/s)
DistToMAV
0.00
0.46
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Message:
All Clear message sent
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Submit
Send All Clear
Get Plan Detail
Cancel Current Flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Get Segment Json
Start Tracking
Modify Plan
Reconnect

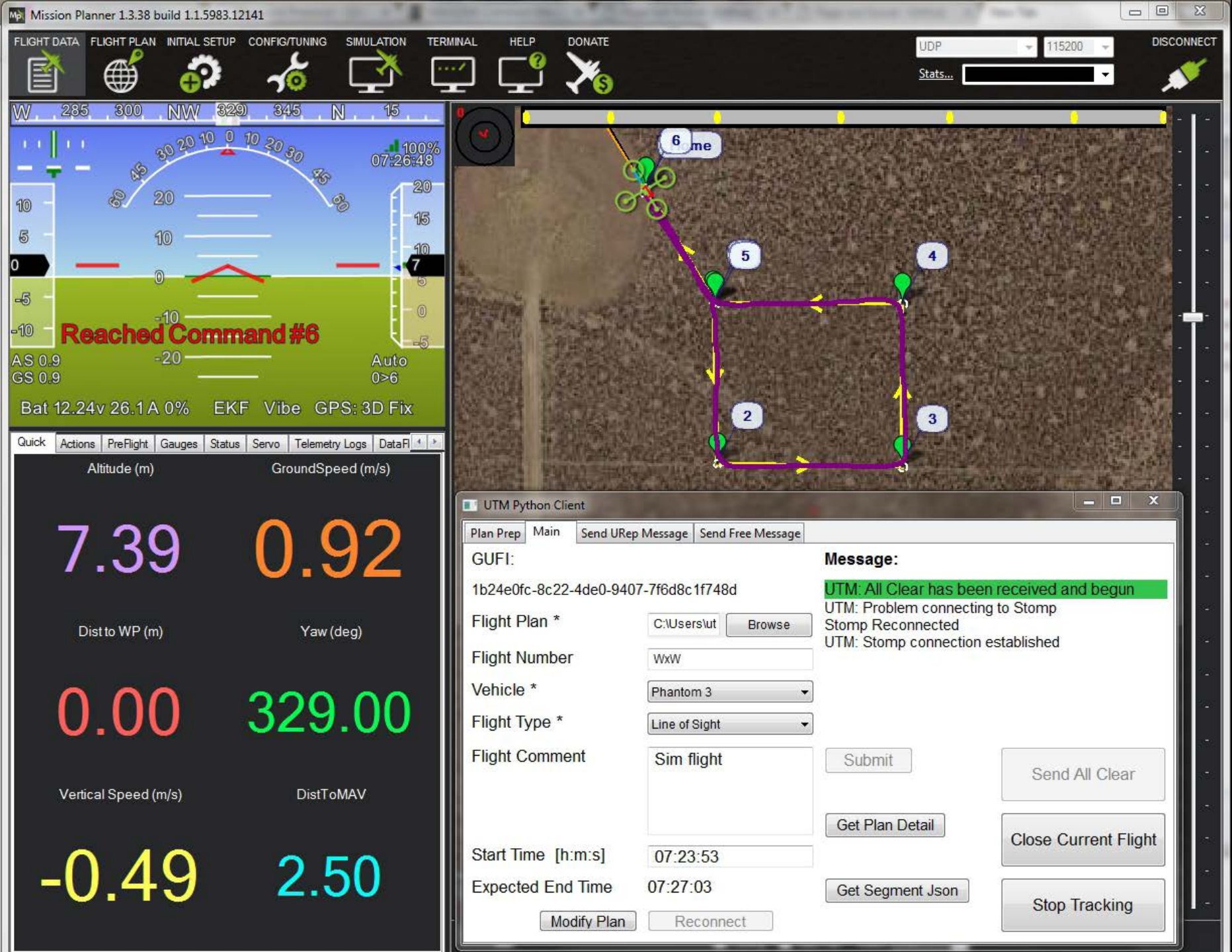
Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
ARMED
Initialising APM...
AS 0.0
GS 0.0
Guided
0>0
Bat 12.54v 3.5 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
0.01
0.00
Dist to WP (m)
Yaw (deg)
0.00
325.19
Vertical Speed (m/s)
DistToMAV
0.00
0.28
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
WARNING - SYSTEM
Time measured for position update of gufi
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d is later
than server received time. Check for clock sync.
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
W 285 300 NW 325 30 345 N 15
100%
07:24:38
AS 0.0
GS 0.0
Guided
0>0
Bat 12.24v 29.4 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
5.21
0.01
Dist to WP (m)
Yaw (deg)
0.00
324.99
Vertical Speed (m/s)
DistToMAV
2.27
0.23
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
WARNING - SYSTEM
Time measured for position update of gufi
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d is later
than server received time. Check for clock sync.
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking


Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
AS 4.0
GS 4.0
Auto
15>1
Bat 12.19v 28.4 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
26.10
4.01
Dist to WP (m)
Yaw (deg)
15.00
147.01
Vertical Speed (m/s)
DistToMAV
1.56
46.19
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
UTM: Problem connecting to Stomp
Stomp Reconnected
UTM: Stomp connection established
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
Stats...
DISCONNECT
120 SE 150 165 179 195 210 SW
100%
07:25:14
AS 4.9
GS 4.9
Auto
38>2
Bat 12.19v 27.0 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
29.98
4.87
Dist to WP (m)
Yaw (deg)
38.00
179.02
Vertical Speed (m/s)
DistToMAV
0.03
96.28
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
UTM: Problem connecting to Stomp
Stomp Reconnected
UTM: Stomp connection established
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
Reached Command #4
AS 2.4
GS 2.4
Auto
86>5
Bat 12.22v 26.5 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
29.99
2.35
Dist to WP (m)
Yaw (deg)
86.00
270.71
Vertical Speed (m/s)
DistToMAV
0.01
131.11
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
UTM: Problem connecting to Stomp
Stomp Reconnected
UTM: Stomp connection established
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking


Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
Reached Command #6
AS 0.9
GS 0.9
Auto
0>6
Bat 12.24v 26.1 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
7.39
0.92
Dist to WP (m)
Yaw (deg)
0.00
329.00
Vertical Speed (m/s)
DistToMAV
-0.49
2.50
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Reconnect
Message:
UTM: All Clear has been received and begun
UTM: Problem connecting to Stomp
Stomp Reconnected
UTM: Stomp connection established
Submit
Send All Clear
Get Plan Detail
Close Current Flight
Get Segment Json
Stop Tracking

Mission Planner 1.3.38 build 1.1.5983.12141
FLIGHT DATA
FLIGHT PLAN
INITIAL SETUP
CONFIG/TUNING
SIMULATION
TERMINAL
HELP
DONATE
UDP
115200
DISCONNECT
Stats...
W 285 300 NW 329 345 N 15
100%
07:27:08
AS 0.0
GS 0.0
RTL
0>6
Bat 12.27v 22.8 A 0%
EKF
Vibe
GPS: 3D Fix
Quick
Actions
PreFlight
Gauges
Status
Servo
Telemetry Logs
Altitude (m)
GroundSpeed (m/s)
11.70
0.03
Dist to WP (m)
Yaw (deg)
0.00
329.02
Vertical Speed (m/s)
DistToMAV
-1.49
0.27
UTM Python Client
Plan Prep
Main
Send URep Message
Send Free Message
GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d
Flight Plan *
C:\Users\ut
Browse
Flight Number
WxW
Vehicle *
Phantom 3
Flight Type *
Line of Sight
Flight Comment
Sim flight
Start Time [h:m:s]
07:23:53
Expected End Time
07:27:03
Modify Plan
Stomp Connect
Message:
UTM: Plan has been Closed.
Submit
Send All Clear
Get Plan Detail
Cancel Current Flight
Get Segment Json
Start Tracking

Software Releases

- Products available via Software Usage Agreement for partners with Space Act Agreement or other qualifying contract:
  - UTM Server (virtual machine, no source code)
  - Python Reference Client (includes source code)
  - UTM Manager Display (IOS App, no source code)
- Dates:

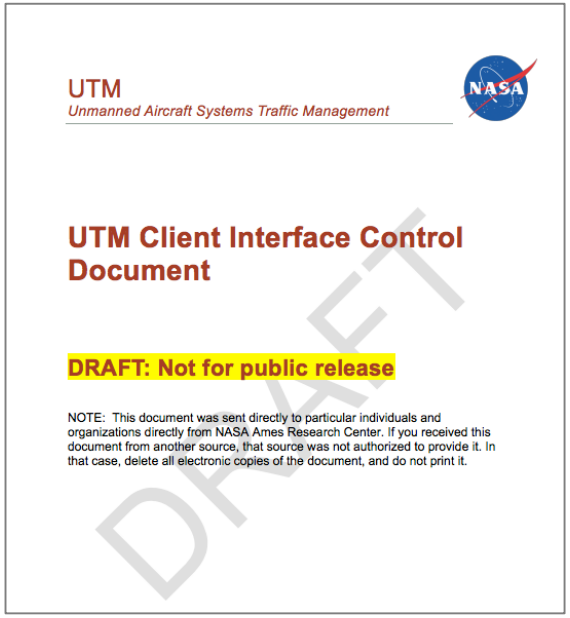
  TCL 1 – Dec 2015

  TCL 2 – Dec 2016 (anticipated)

Write your own client?

- Submit an RFI response or sign Space Act Agreement
- Request TCL2 Client ICD and credentials
- Create client
- Test according to UTM Client Test Plan document

API Documentation

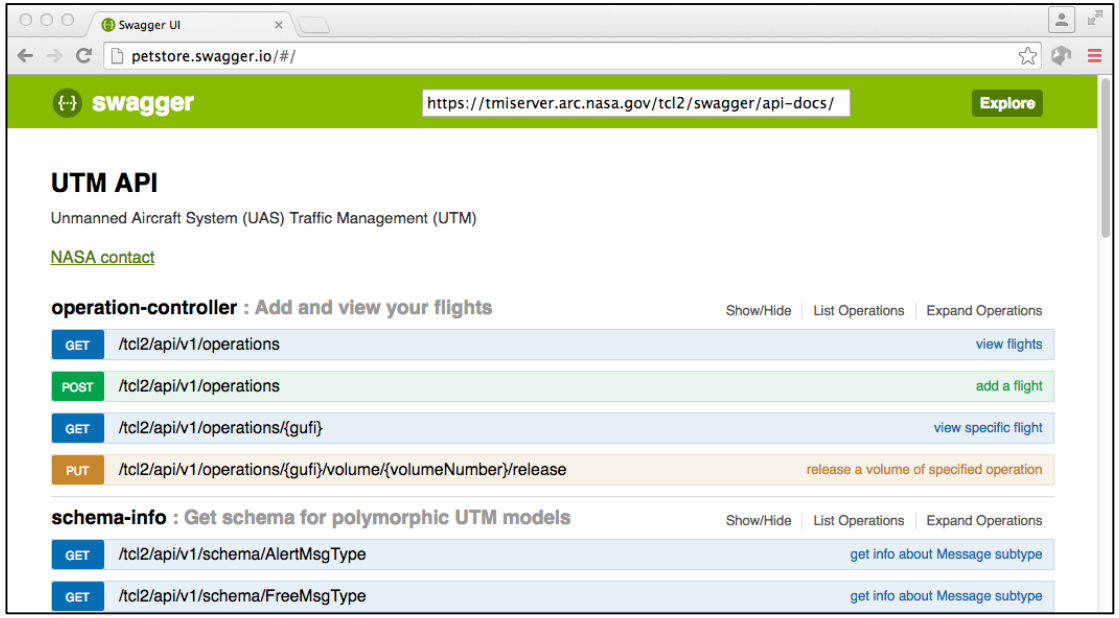

UTM
Unmanned Aircraft Systems Traffic Management

UTM Client Interface Control Document

DRAFT: Not for public release

NOTE: This document was sent directly to particular individuals and organizations directly from NASA Ames Research Center. If you received this document from another source, that source was not authorized to provide it. In that case, delete all electronic copies of the document, and do not print it.

DRAFT



Client Interface Control Document

Online documentation – Swagger compatible

Questions?

daniel.g.mulfinger@nasa.gov