

UTM TCL2

Software Design

Daniel Mulfinger

What is the UTM Software?

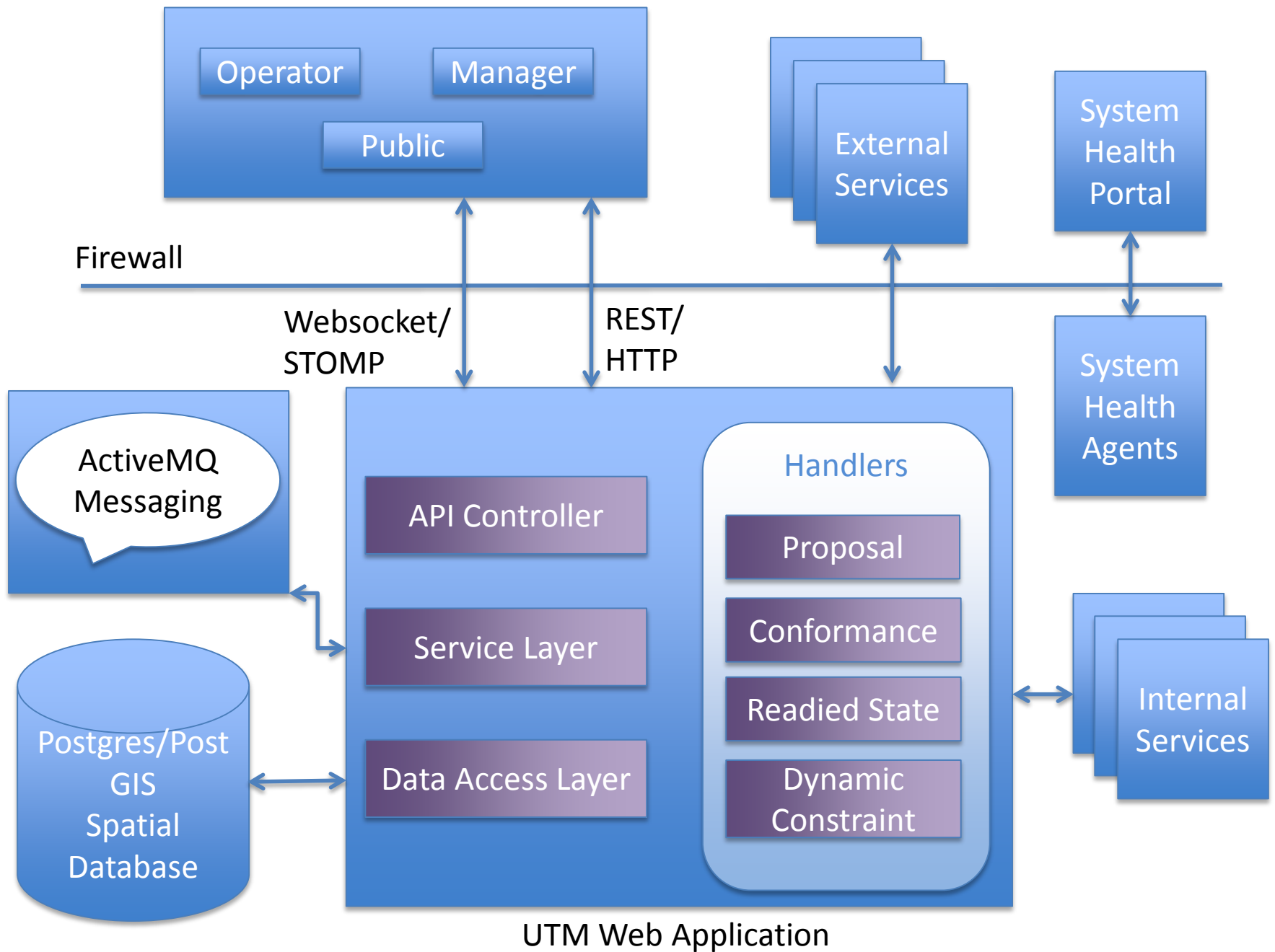
- Research Prototype Software
- Implements the UTM Concept of Operations
- Web Application
- Two pieces
 - UTM Core
 - Set of Services
- ~25K lines of code
- Agile-based with 4-week sprints

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 **Stomp** 
- PostgreSQL + PostGIS 
- JTS Topology Suite
- REST (Representational State Transfer)
- Jenkins 
- Atlassian 
- SonarQube 

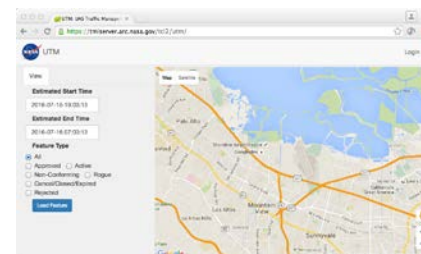
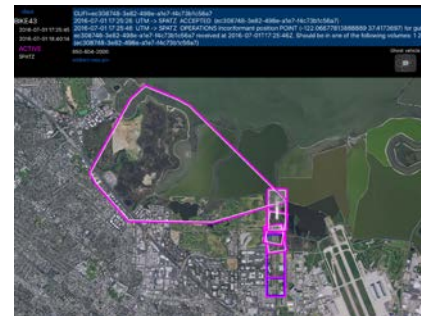


User Roles

- 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)

FLIGHT DATA

FLIGHT PLAN

INITIAL SETUP

CONFIG/TUNING

SIMULATION

TERMINAL

HELP

DONATE

UDP DISCONNECT

Stats...

W 285 300 NW 32630 345 N 15

100% 07:23:37

DISARMED

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 DataF

Altitude (m)

0.00

GroundSpeed (m/s)

0.00

Dist to WP (m)

0.00

Yaw (deg)

326.13

Vertical Speed (m/s)

0.00

DistToMAV

0.32

6 me

5

4

2

3

UTM Python Client

Plan Prep Main Send URep Message Send Free Message

GUF1: Message:

Flight Plan *

C:\Users\lut

Browse

Flight Number

WxW

Vehicle *

Phantom 3

Flight Type *

Line of Sight

Flight Comment

Sim flight

Submit

Start Time [h:m:s]

Expected End Time

TBD

Get Plan Detail

Get Segment Json

Modify Plan

Stomp Connect

Send All Clear

Cancel Current Flight

Start Tracking

FLIGHT DATA

FLIGHT PLAN

INITIAL SETUP

CONFIG/TUNING

SIMULATION

TERMINAL

HELP

DONATE

UDP

115200

DISCONNECT

Stats...

W 285 300 NW 32630 345 N 15

100% 07:23:43

DISARMED

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 DataF

Altitude (m)

0.00

GroundSpeed (m/s)

0.00

Dist to WP (m)

0.00

Yaw (deg)

326.13

Vertical Speed (m/s)

0.00

DistToMAV

0.32

6 me

5

4

3

2

UTM Python Client

Plan Prep Main Send URep Message Send Free Message

GUFU: Message:

Flight Plan * C:\Users\lut Browse UTM: Stomp connection established

Flight Number WxW

Vehicle * Phantom 3

Flight Type * Line of Sight

Flight Comment Sim flight Submit

Start Time [h:m:s]

Expected End Time TBD

Modify Plan Reconnect

Send All Clear

Cancel Current Flight

Start Tracking

Get Plan Detail

Get Segment Json



Quick Actions PreFlight Gauges Status Servo Telemetry Logs DataF

Altitude (m) GroundSpeed (m/s)

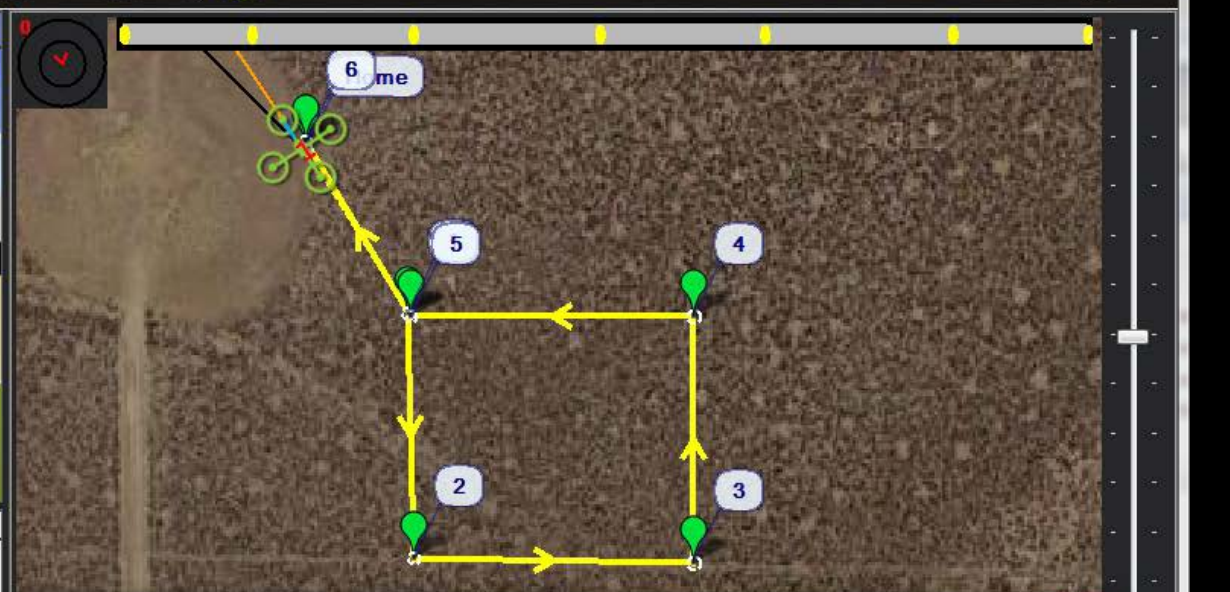
0.00 0.00

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

GUFU: 1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Message: Plan submitted, please wait for approval.

Flight Plan * C:\Users\lut Browse Stomp Reconnected

Flight Number WxW

Vehicle * Phantom 3

Flight Type * Line of Sight

Flight Comment Sim flight

Submit

Get Plan Detail

Start Time [h:m:s] 07:23:53

Expected End Time 07:27:03

Get Segment Json

Modify Plan Reconnect

Send All Clear

Cancel Current Flight

Start Tracking



Quick Actions PreFlight Gauges Status Servo Telemetry Logs DataF

Altitude (m) GroundSpeed (m/s)

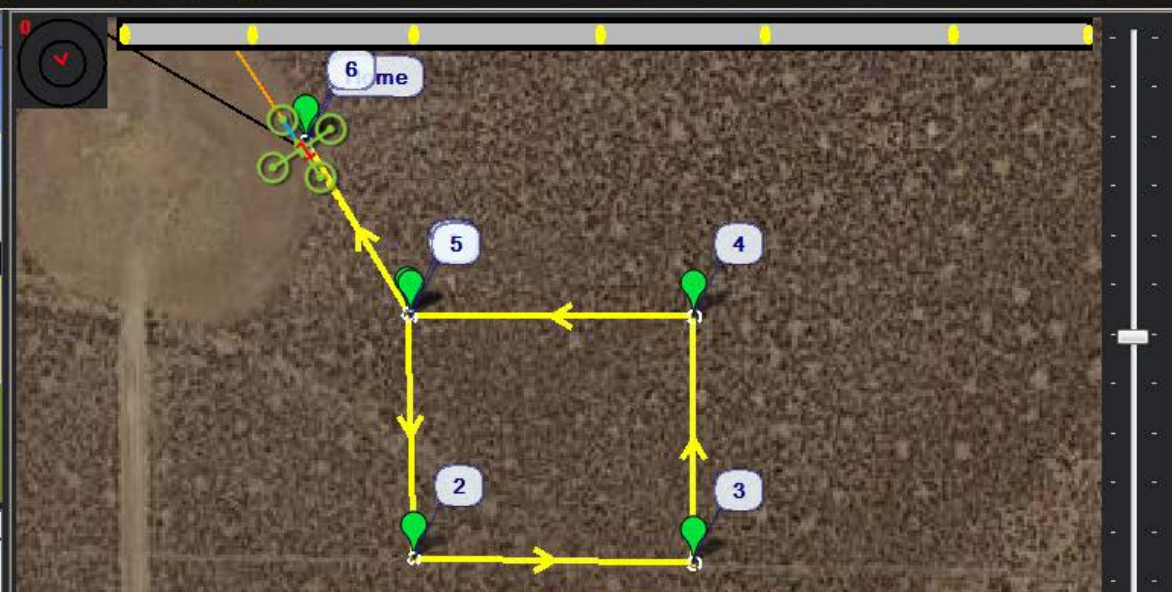
0.00 0.01

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

GUFU: 1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan * C:\Users\lut 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

Message: UTM: Plan has been Accepted.

Submit

Get Plan Detail

Get Segment Json

Send All Clear

Cancel Current Flight

Start Tracking

Modify Plan Reconnect



Altitude (m)

0.01

GroundSpeed (m/s)

0.01

Dist to WP (m)

0.00

Yaw (deg)

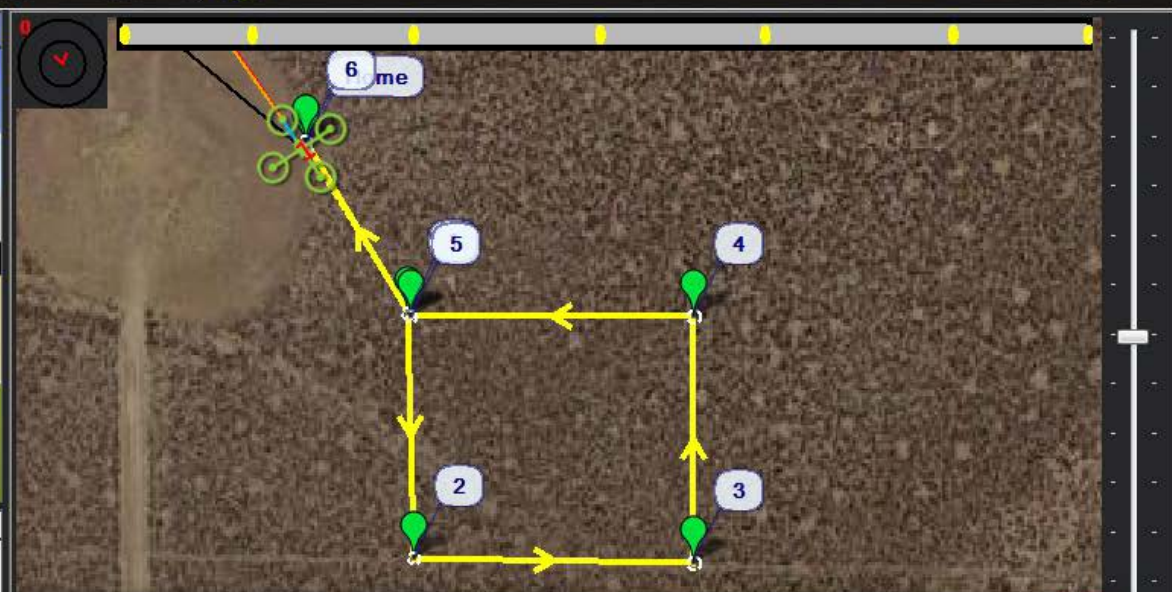
325.69

Vertical Speed (m/s)

0.00

DistToMAV

0.46



UTM Python Client

Plan Prep

Main

Send URep Message

Send Free Message

GUF1:

1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Message:

All Clear message sent

Flight Plan *

C:\Users\lut

Browse

Flight Number

WxW

Vehicle *

Phantom 3

Flight Type *

Line of Sight

Flight Comment

Sim flight

Submit

Start Time [h:m:s]

07:23:53

Get Plan Detail

Expected End Time

07:27:03

Get Segment Json

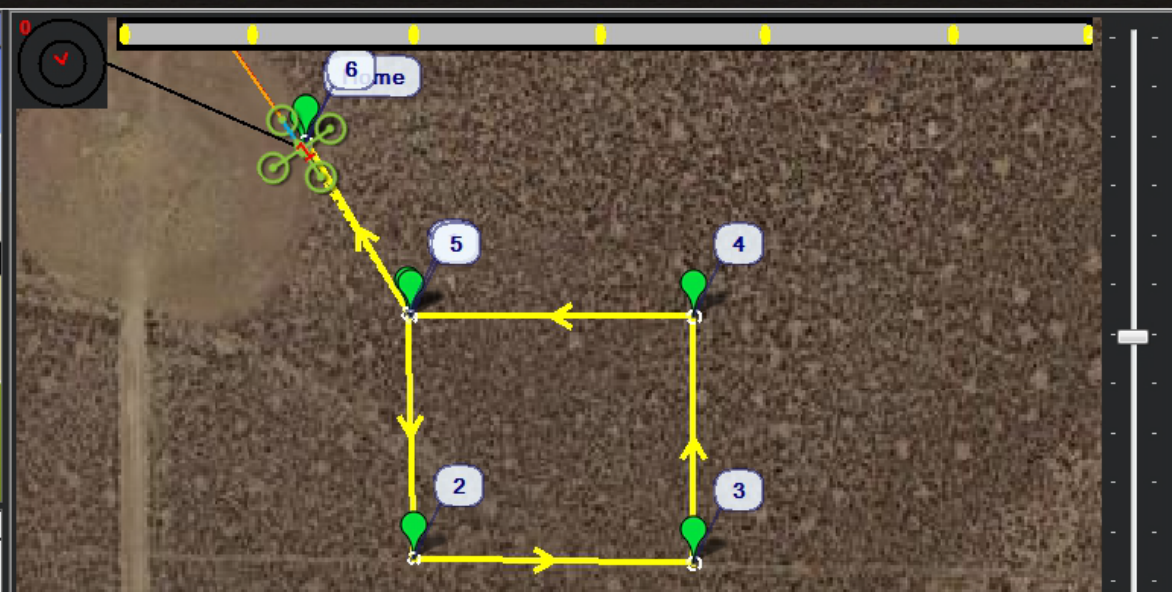
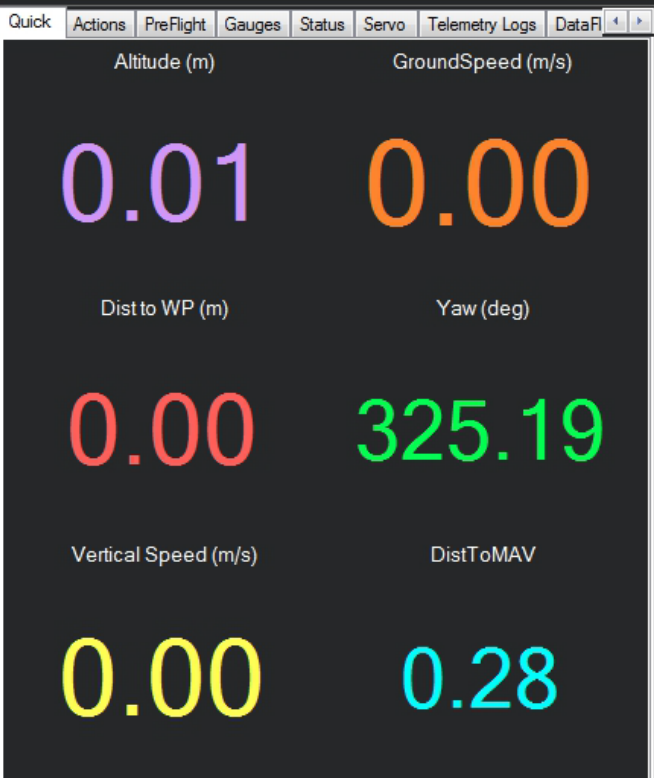
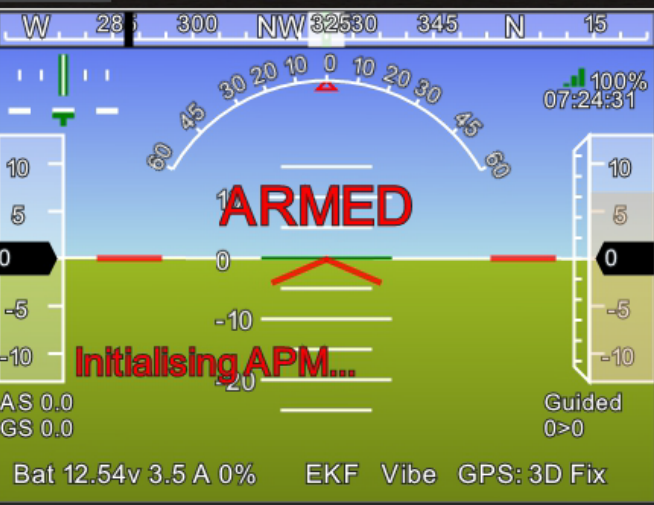
Modify Plan

Reconnect

Send All Clear

Cancel Current Flight

Start Tracking



UTM Python Client

Plan Prep

Main

Send URep Message

Send Free Message

GUFU:

1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan *
C:\Users\lut 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

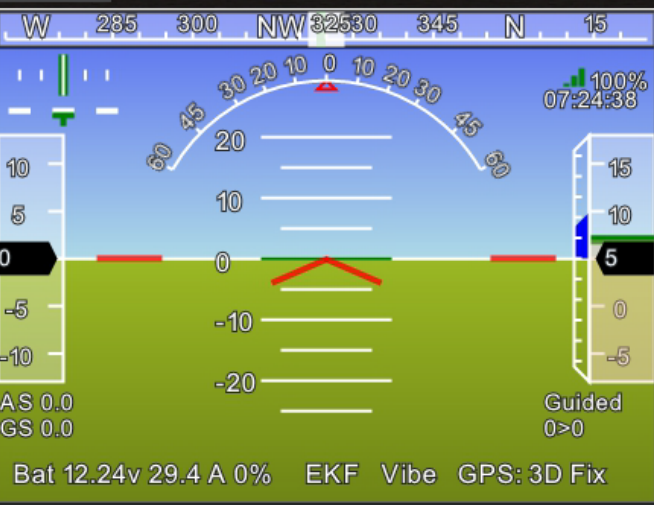
Get Plan Detail

Get Segment Json

Send All Clear

Close Current Flight

Stop Tracking



QuickActionsPreFlightGaugesStatusServoTelemetry LogsDataF

Altitude (m)GroundSpeed (m/s)

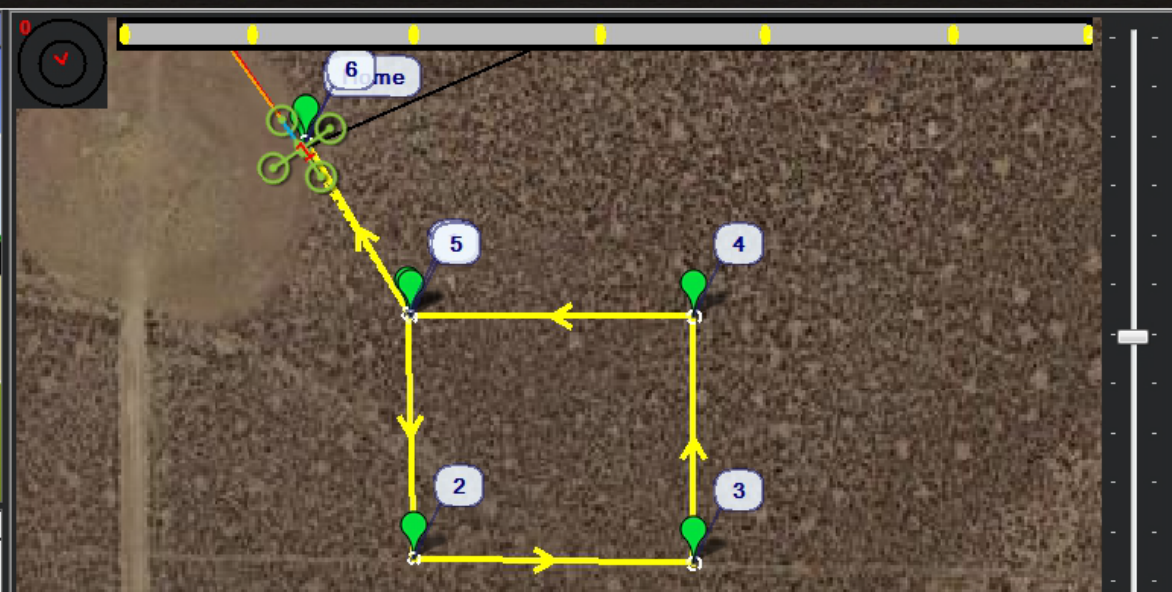
5.210.01

Dist to WP (m)Yaw (deg)

0.00324.99

Vertical Speed (m/s)DistToMAV

2.270.23



UTM Python Client

Plan PrepMainSend URep MessageSend Free Message

GUFI:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan *
C:\Users\lutBrowse

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 PlanReconnect

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

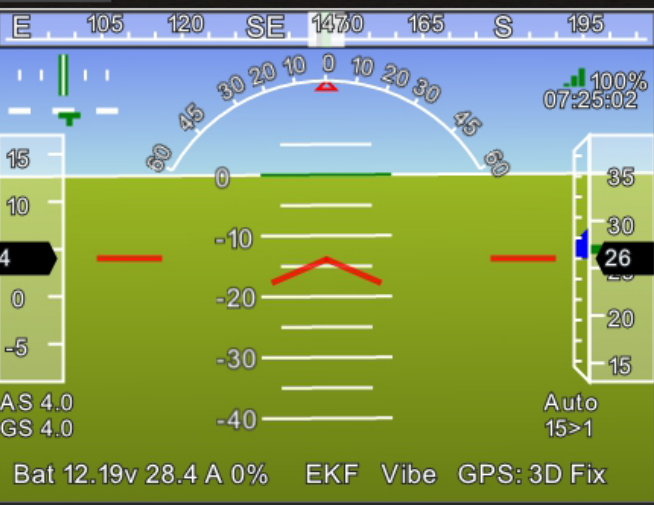
Get Plan Detail

Get Segment Json

Send All Clear

Close Current Flight

Stop Tracking



Altitude (m)

GroundSpeed (m/s)

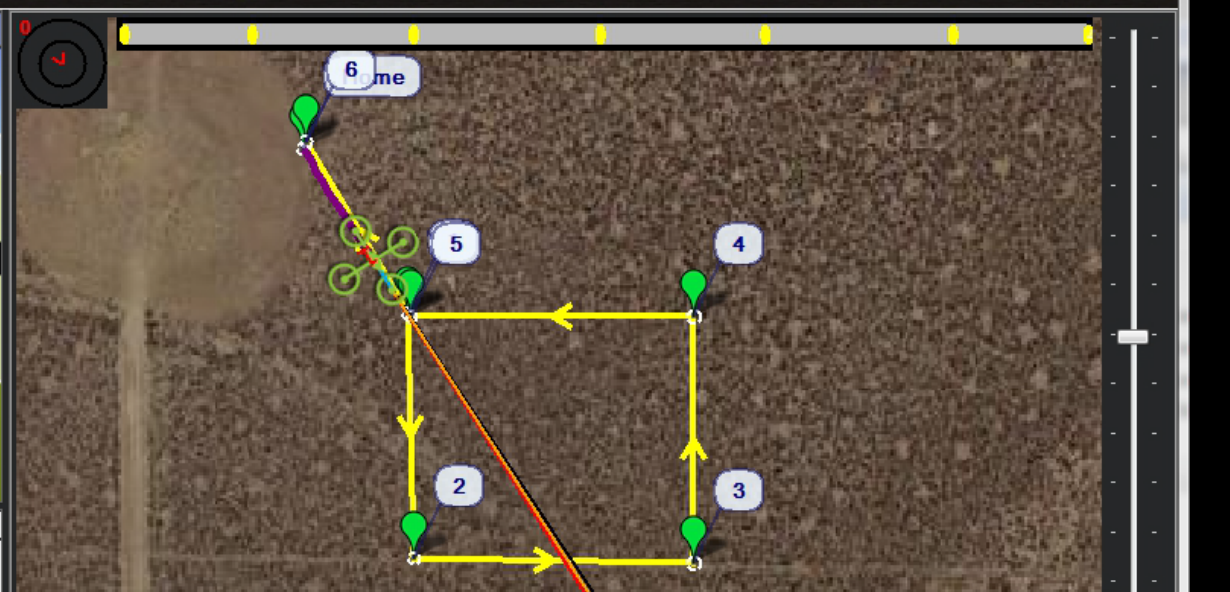
26.10 4.01

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

GUFU:

1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan *

C:\Users\lut Browse

Flight Number

WxW

Vehicle *

Phantom 3

Flight Type *

Line of Sight

Flight Comment

Sim flight

Submit

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

Send All Clear

Get Plan Detail

Close Current Flight

Get Segment Json

Stop Tracking







Quick Actions PreFlight Gauges Status Servo Telemetry Logs DataF

Altitude (m) GroundSpeed (m/s)

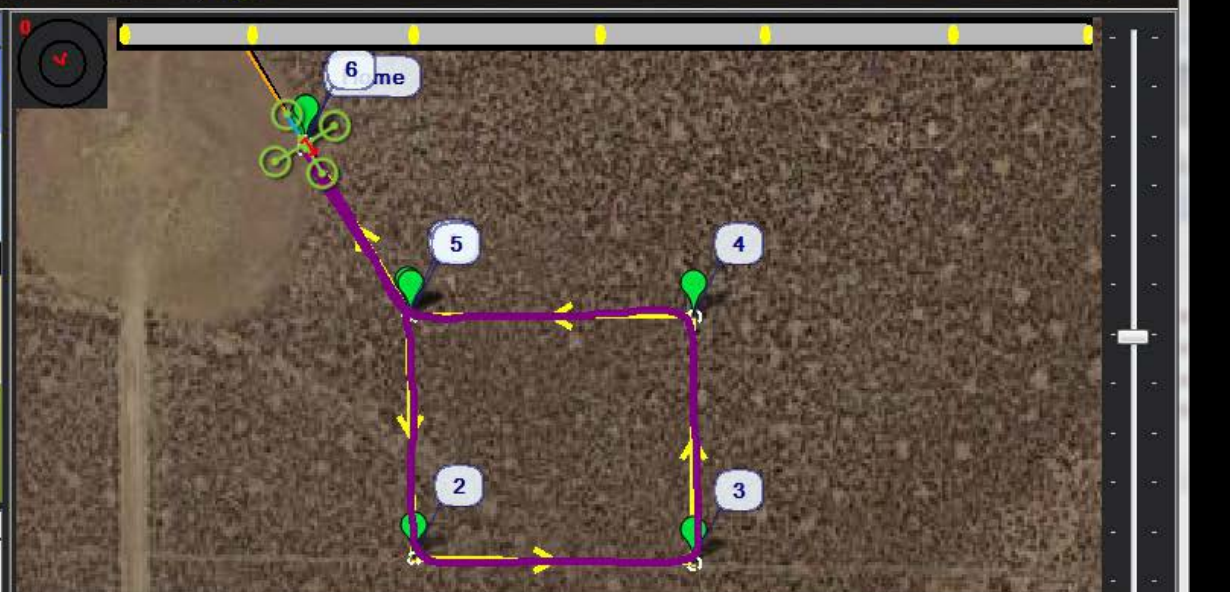
7.39 0.92

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

GUFU:
1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan *
C:\Users\lut 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

Get Plan Detail

Get Segment Json

Send All Clear

Close Current Flight

Stop Tracking



Altitude (m)

11.70

GroundSpeed (m/s)

0.03

Dist to WP (m)

0.00

Yaw (deg)

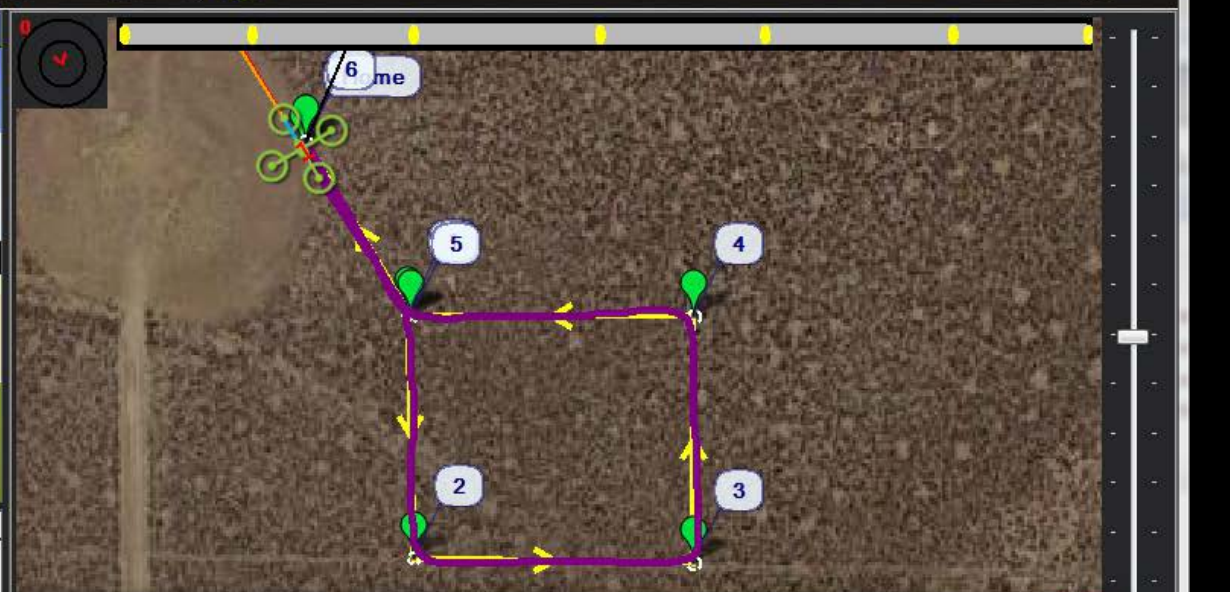
329.02

Vertical Speed (m/s)

-1.49

DistToMAV

0.27



UTM Python Client

Plan Prep

Main

Send URep Message

Send Free Message

GUFU:

1b24e0fc-8c22-4de0-9407-7f6d8c1f748d

Flight Plan *

C:\Users\lut

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

Get Plan Detail

Get Segment Json

Send All Clear

Cancel Current Flight

Start Tracking

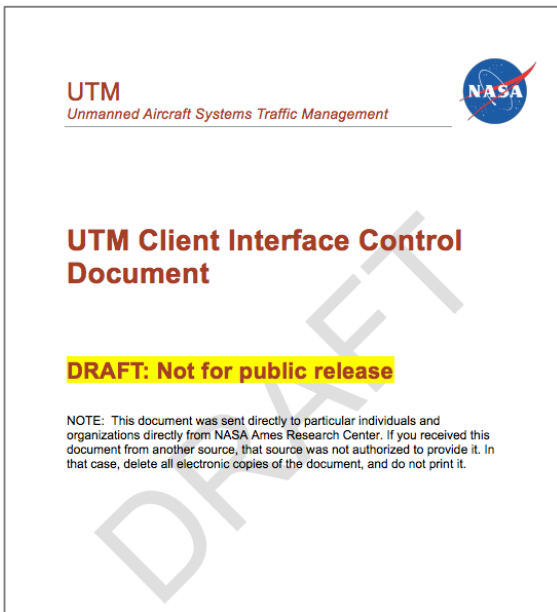
Software Releases

- 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)

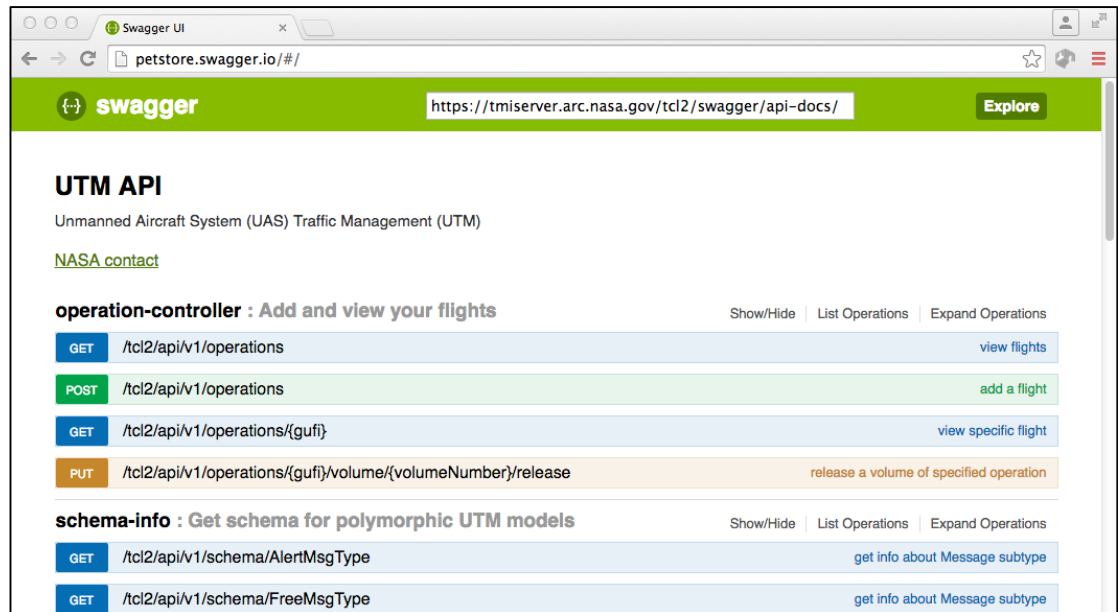
Write your own client?

- 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



Client Interface
Control Document



Online documentation – Swagger compatible

Questions?

daniel.g.mulfinger@nasa.gov