Safer Paragliding by Applying Google Glass as HUD

OSTIV Meteorological Panel Meeting 6.- 7. 2. 2015

Oludeniz Turkey

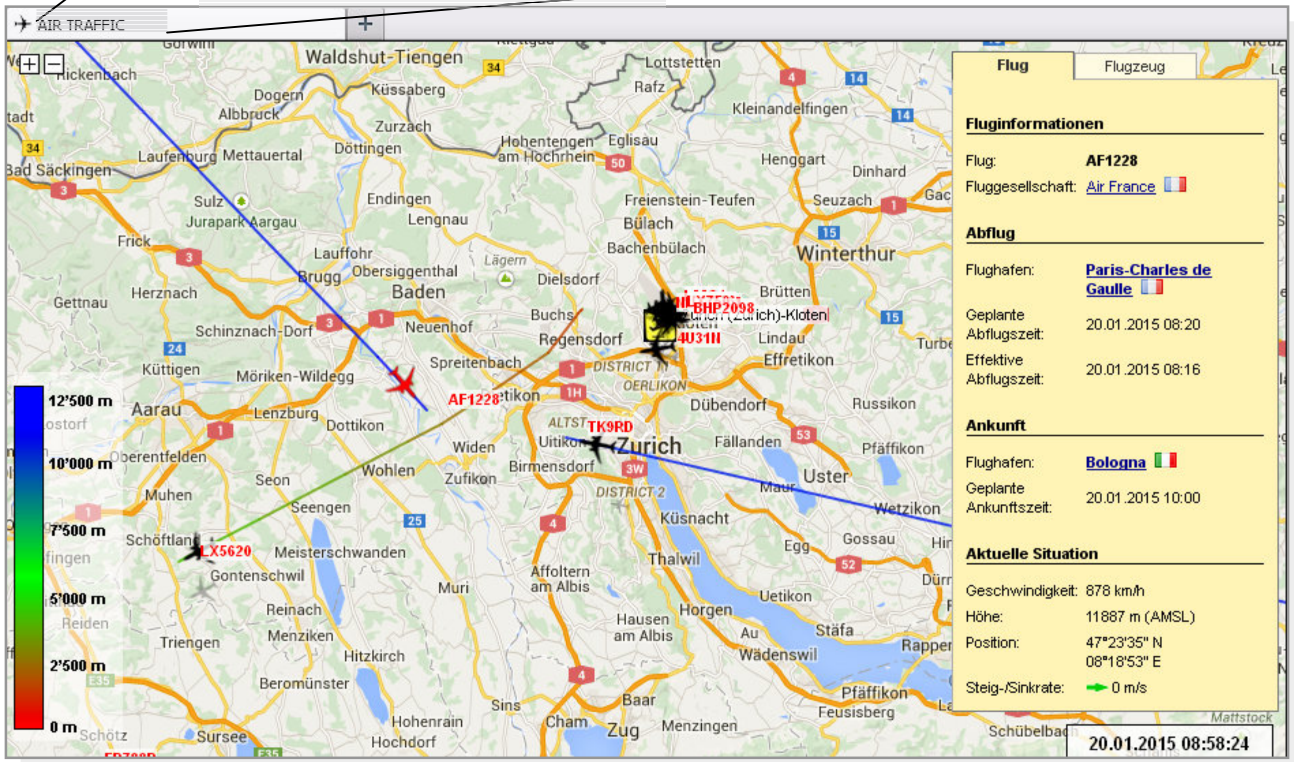
Summary of the Talk

- Introduce myself with some resent works related to this panel
- Reason for start paragliding
- Aviation obstacles in Switzerland
- Actual trends in paraglider display devices
- HUD for paragliders as a - almost - perfect use case for Google Glass
  - freehand
  - no cockpit
  - match of interaction concept
- Future outlook and work in progress

Air Traffic Mashup Zurich 2008

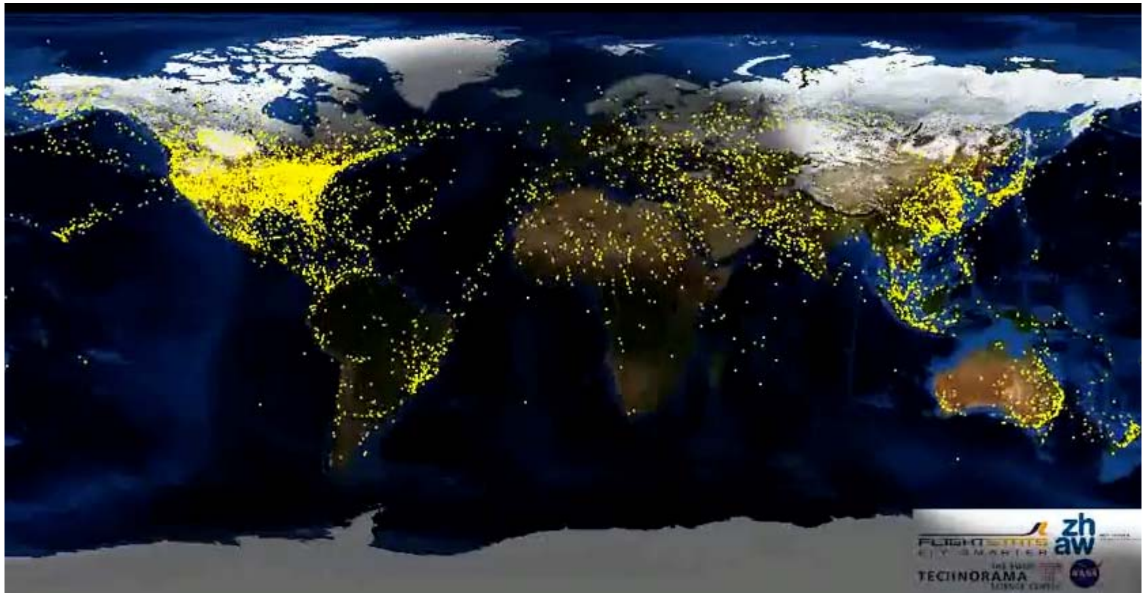
- One of the first Google Map sites with moving artifacts (planes)
- Because of legal issues restricted to Switzerland area
- -> FlightRadar24

http://radar.zhaw.ch



Air Traffic Worldwide 2009

- Visualization of worldwide air traffic in time laps (72' seconds)
- Shown in the Technorama Winterthur in so called Orbitarium
- -> YouTube

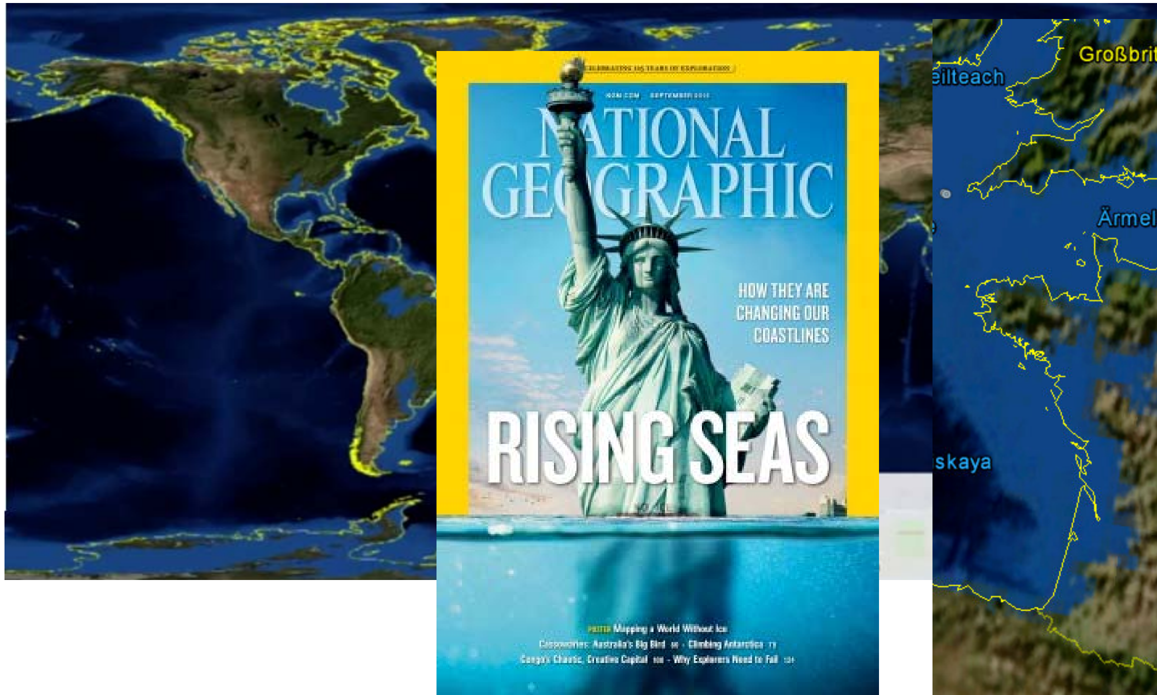


1.5m lobe with two HD projectors inside

Technorama Winterthur

Climate Change Visualization 2010 (B.M. 3000)

- Visualization of the climate change consequences (from LGM until 10'000 B.C.)
- Again for the Orbitarium and "Science on a Sphere" of NOAA
  - CO_2-emissions, climate change, vegetation, glaciers, sea level, migration of population
- IT responsible for 2% CO_2 global emissions - equal to aviation



September 2013

How did I Start Paragliding

- Sabbatical spring 2011 -> face new challenge, do some research
  - Visiting research to Japan -> Earthquake in Fukushima
  - Visiting research to New Zealand -> Earthquake in Christchurch
  - run out of options -> chosen the more riskless

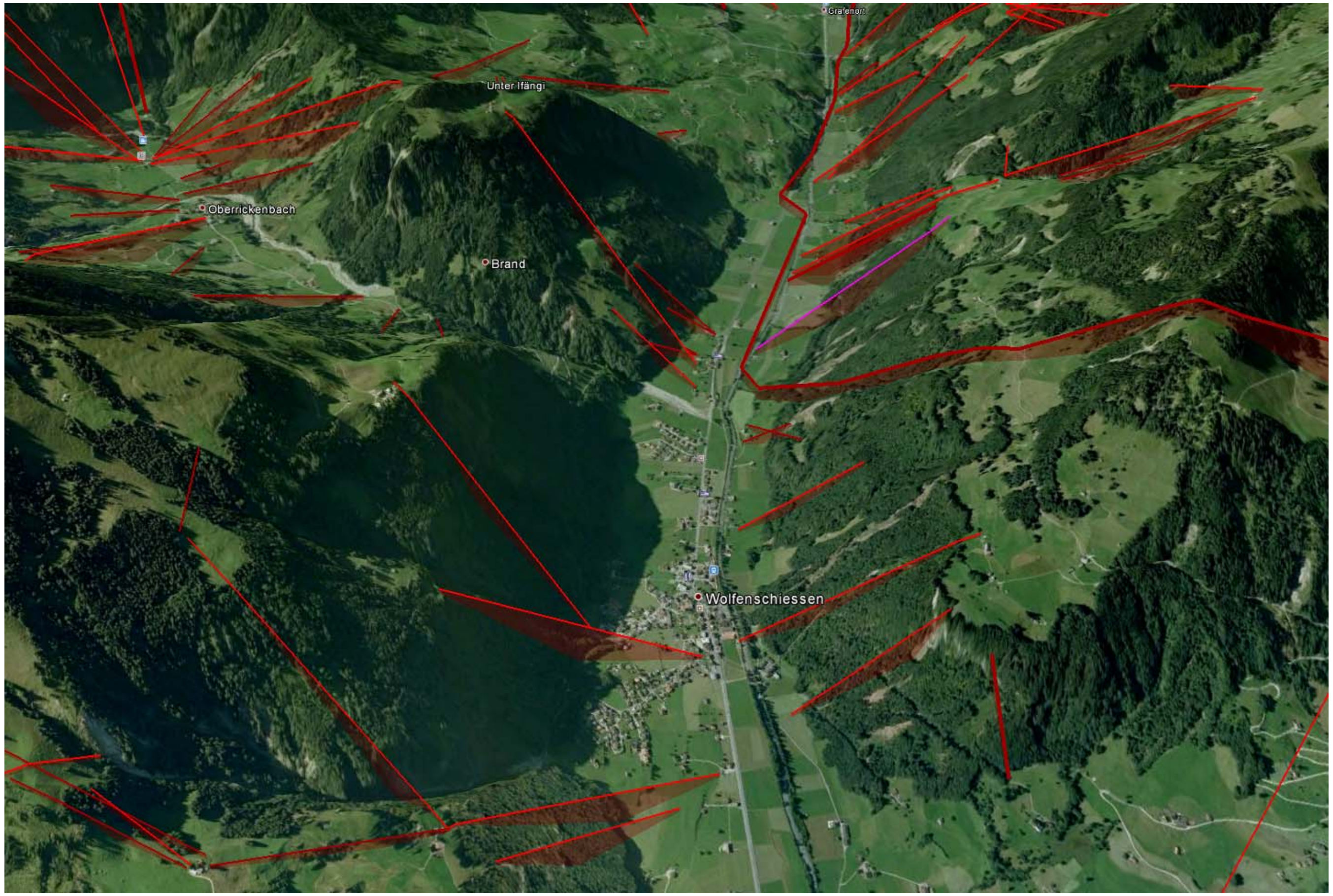
class for difficult pupil in Zurich

paragliding

Problematic of the Aviation Obstacles

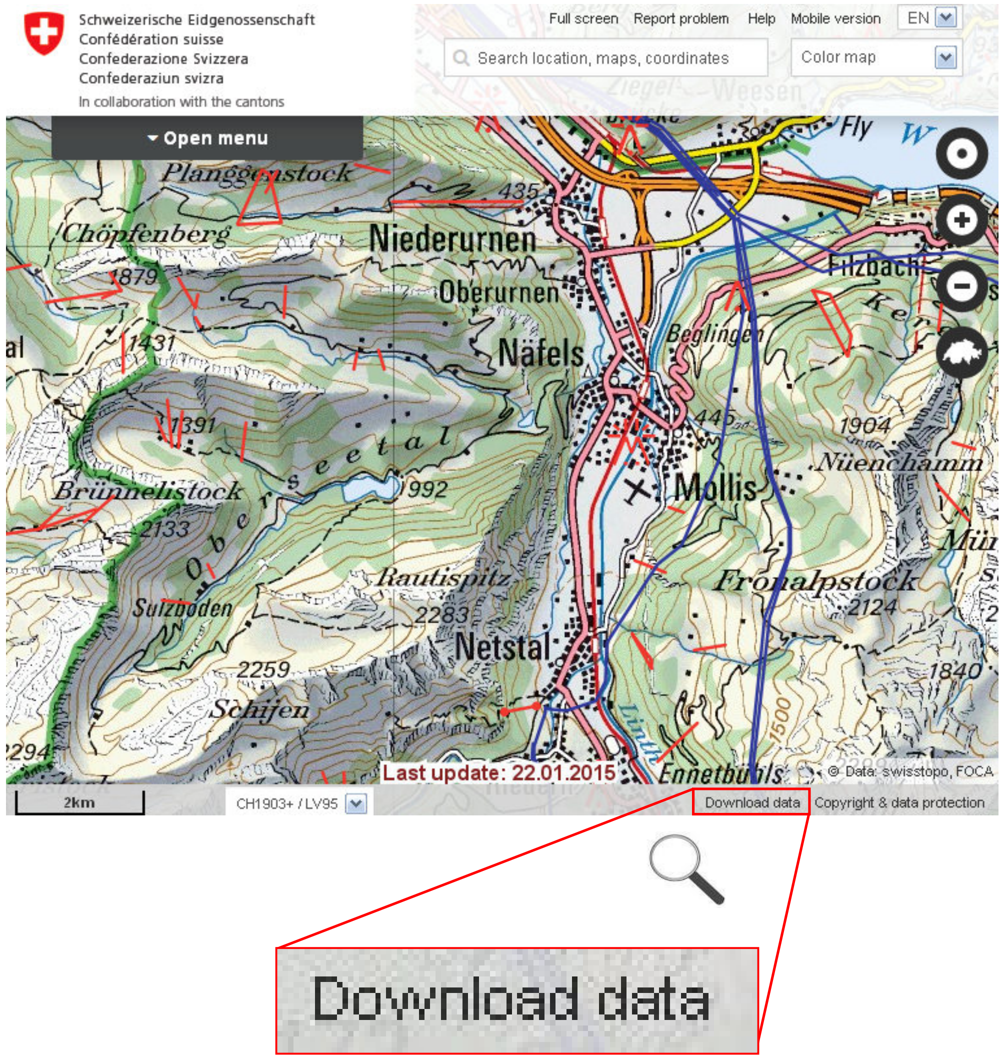
Aviation Obstacles in Switzerland

- Ropeway cables, power lines, telephone lines
- In total, more than 7'000 obstacles in Switzerland



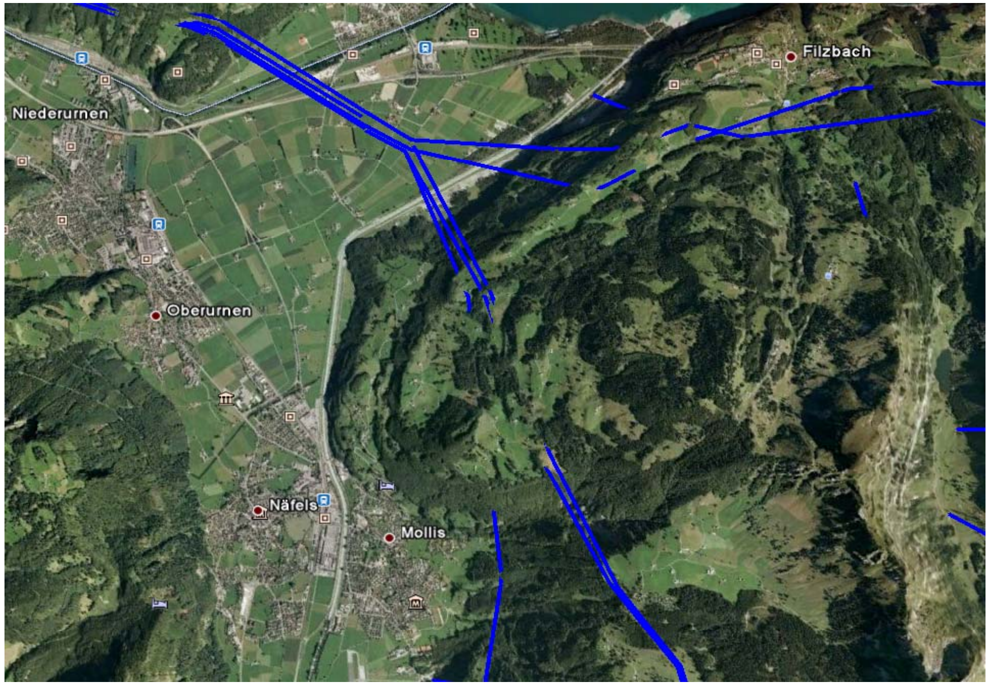
BAZL Obstacle Data Freely Available Since 2012

- Swiss Federal Aviation Administration
- Open Government Data initiative
- Find the data on their site
  - URL: http://map.bazl.admin.ch
- Almost daily update
- Link to a KML File



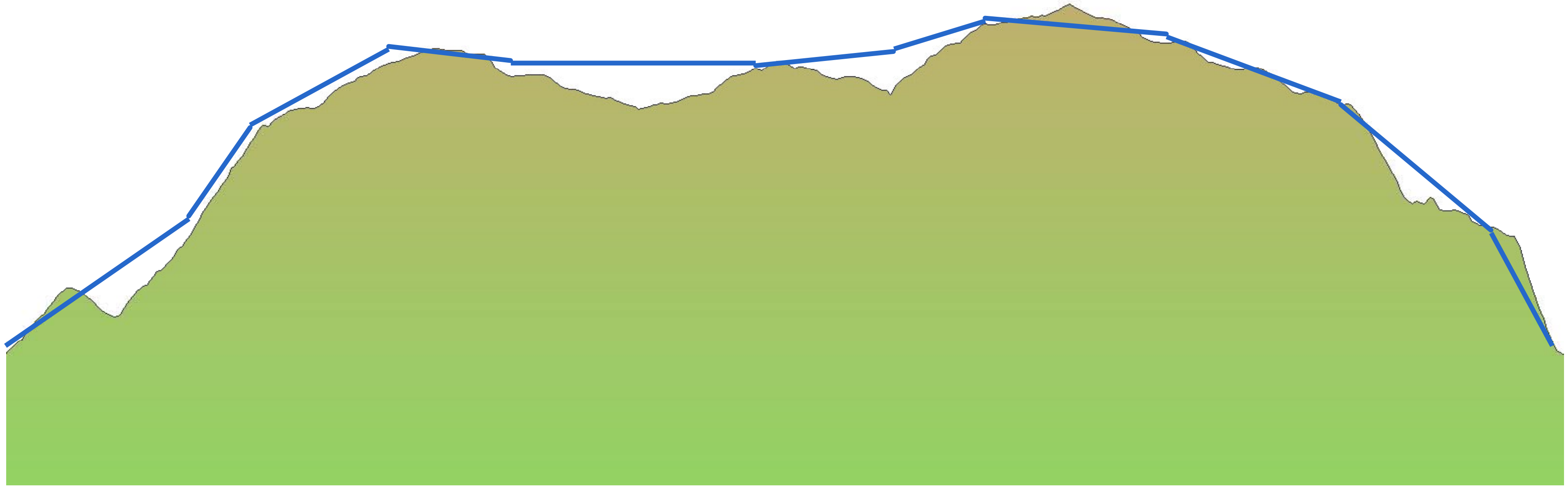
BAZL KML File

- KML File = Google Earth overlay
- Visualize directly in Google Earth
- Cables go through the ground
  - Reason: partially not top amsl but hight of base
  - to few and wrong support points
  - Dates partially from the 50s
- For fixed wing airplanes not an issue
  - keep larger ground clearance
- Paraglider fly closer to the terrain
- Big issue for Rega



BAZL KML File

- Longitudinal cut indicates the problem
- Not enough and wrong supporting points
- Cables run through the terrain



Enhancement of Data

Determination of a Realistic Shape

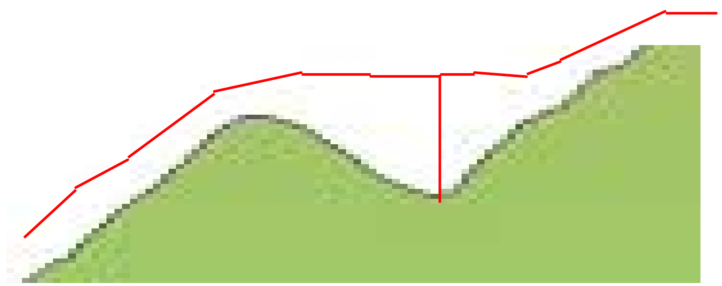
- Topography
  - Topographical data via *Google Geocoding API*
  - About 40 additional supporting points between two BAZL points

- Estimated structure high (e.g. pylons) dependent on
  - Kind of the obstacle
    - *ropeway, power line, telephone line*
  - Length of the obstacle

- Result: Obstacle parallel to the topography

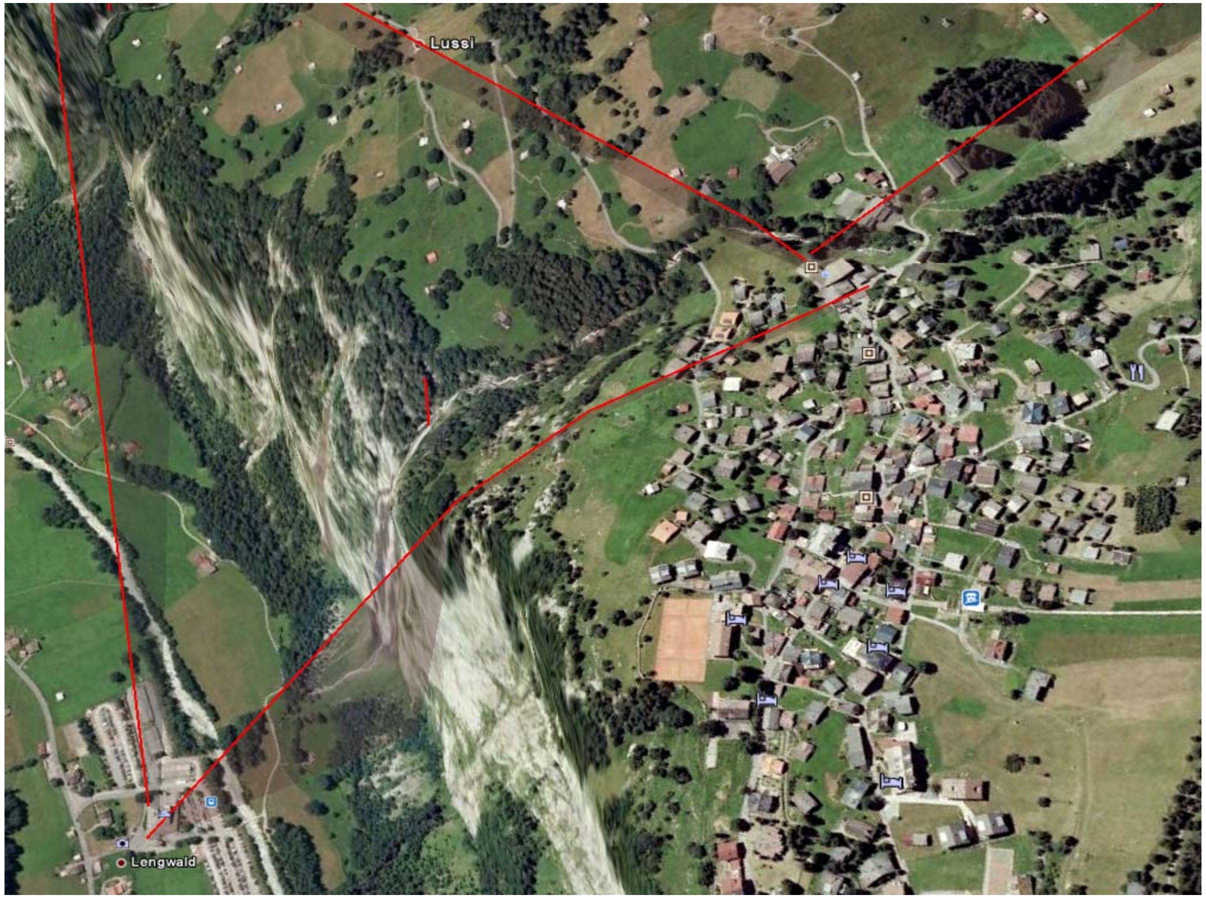
… Determination of a Realistic Shape

- Constraints of the obstacles (= heuristics or AI ;-))
  - Maximal slope of cableway (z.B. Mürren 160%)
  - Position of pylons as far as known
  - ...
- Review of the shape
  - Visual plausibility using Google Maps
  - Imply additional BAZL values (agl)
  - Photos, test flights
- Algorithm for reduction of supporting points
  - To meet HW constraints of flight instruments
  - Special algorithm
    - *et the end only double the supporting points of BAZL*



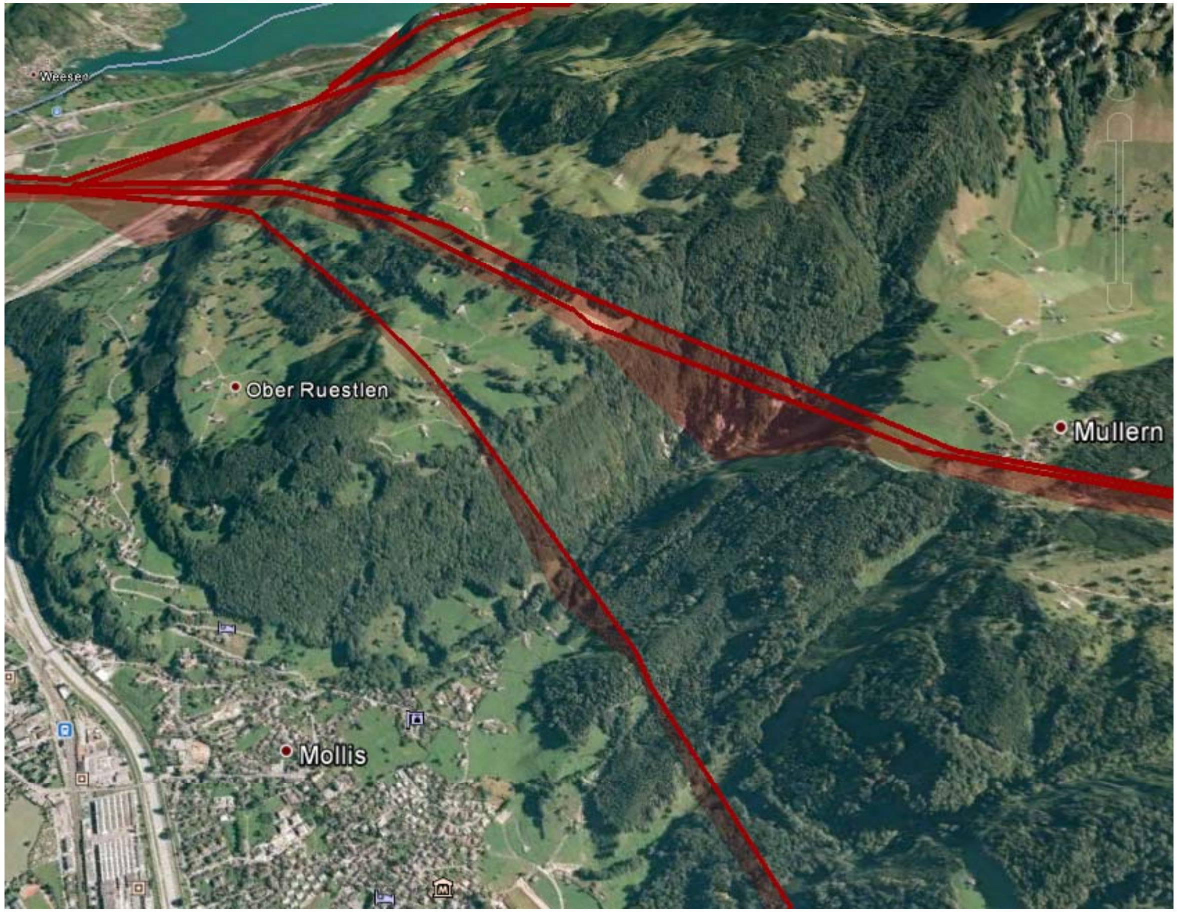
Check of the Results

- Check plausibility visually
  - e.g. Cableway of Mürren



Check of the Results

- Test flights (myself and colleagues)
  - e.g.power line near Mollis



Flight Instruments for Paraglider

Cockpit of a Glider

Flight Instruments for Paragliders

Vario

Offline
Maps

Smartphone
Emergency
Live (Wetter-)Daten

Radio

Cockpit of a Paraglider

- Ad-hoc solutions on top of the front-container
- Numerous independent devices -> costs/accumulators charge
- Spacial constraints
- No dazzling protection

Flight Instrument based on Google Glass and SensBox

Flytec SensBox Technical Specifications

- Position via GPS
- Atmospheric pressure/barom. height
- Compass
- Accelerometer
- Three axis gyrometer
- **Bluetooth Low Energy (BLE)**

Google Glass as HUD

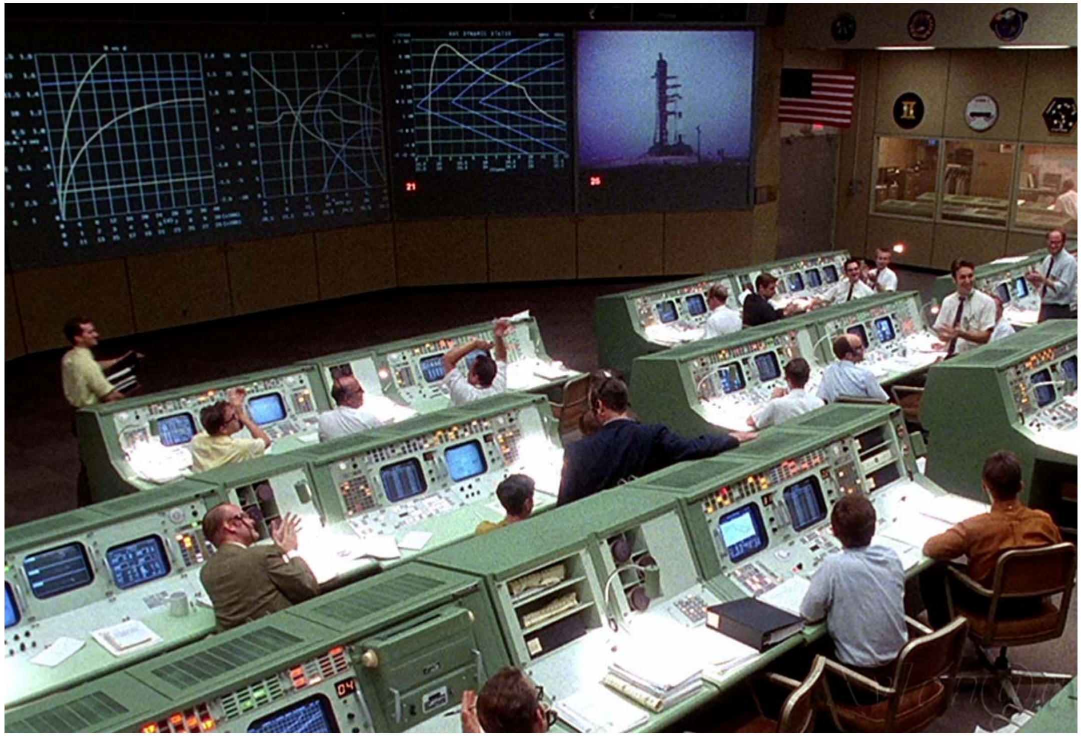
- Convenient form factor
  - lightweight (ca 50g) and comfortable
- Computing power
  - Built into HUD
- Programmability
  - Android 4.4.2
- Interfaces
  - WLAN, BLE

Apollo 11 1969 - NASA Mission Control Center

- 5 IBM System/360 Model 75
- 1 MIPS (x 5)
- 1 MB of Memory (x 5)
- Power consumption: several Megawatt
- Program: 6 Million Lines of Code

- 3'000 IBM Employees for programming and operating

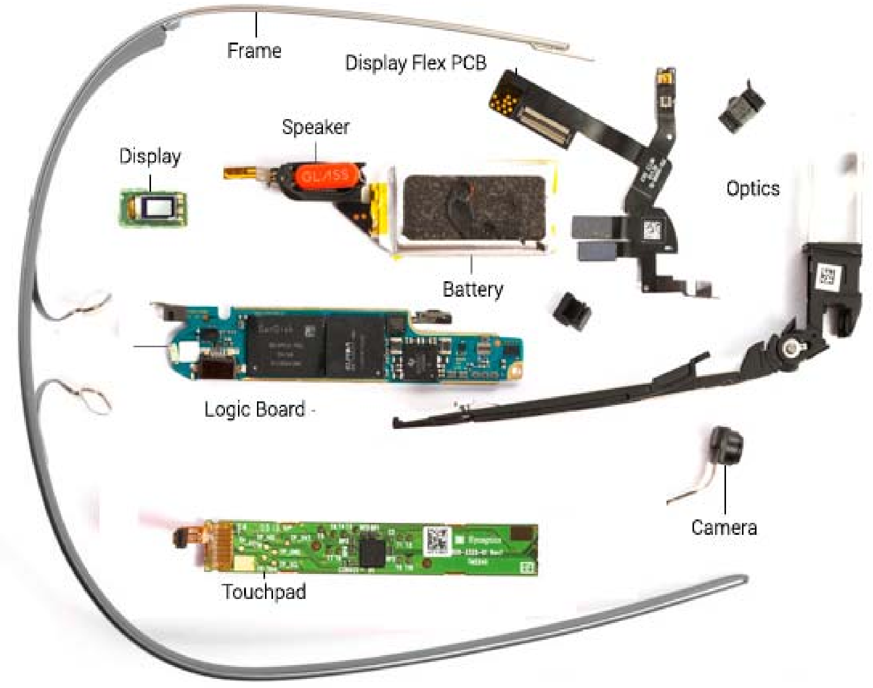
- Renting fee $50,000 to $80,000 p.m.
- To buy $2.2 Million to $3.5 Million
- 25,000h MTBF (~3 years)



Google Glass (one) Specification

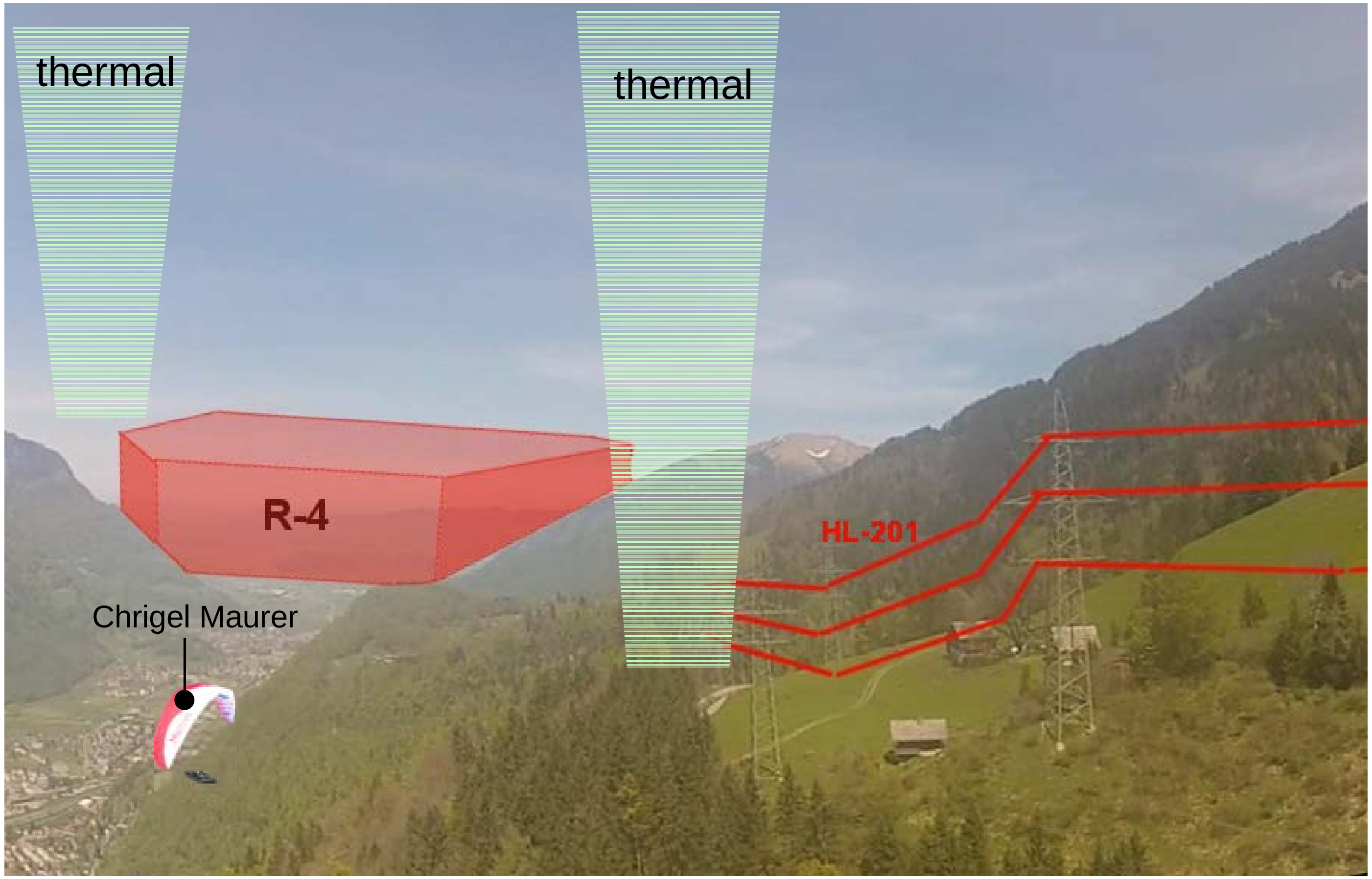
- Dual Core CPU (TI OMAP 4430 ~1 GHz)
- 500 MIPS -> **x 10..100**
- 1 GB RAM/ 16 GB SSD **x 100..200**
- 1.6 Watt **x 10^{-7}**
- 12 Millions Lines of Code (Java, C/C++, XML) **x 2**

- Speaker/Microphone (bone conduct)
- Camera
- Display: 640x360
- Interfaces
  - WLAN
  - Bluetooth Low Energy (BLE)
- Missing
  - GSM, GPS



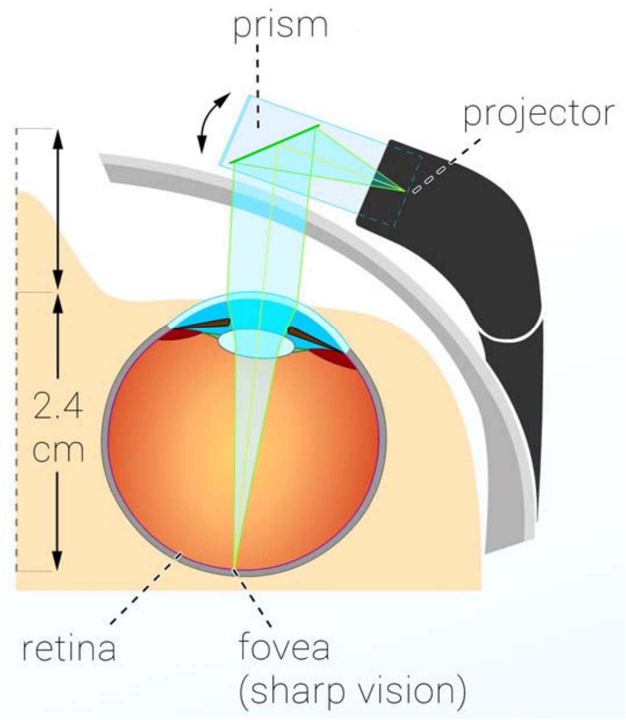
Google Glass - What cannot been seen - yet

- No augmented reality -> but might be the goal



Google Glass - What can be seen

- Prism projection
  display: 640x360 Pixel
- Impression of a **25” Displays** in
  distance of app. **2 m**



Google Glass - What can be seen

- Unilateral, semitransparent
  - with an enclosure also good contrast in bright sunlight conditions
- You may also "look through"
- Environment in sight

Video

Design for Glass

Functionality Base level - implemented

- Technical Constraints
  - **Google Glass** as display device
  - **SensBox** for data delivery
  - Data transmission via **Bluetooth Low Energy**

- **Flightspecific base date**
- **Barometrical height with chances and traces**
- **Position (GPS)**
- **Heading**
- **Speed over ground**
- **Wind direction**
- **Thermal assistance**
- **Obstacle data**

Functionality 2nd Level

- **Altitude above ground**
  - **Terrain data**
  - **via SRTM 2015 in 1 arc-second resolution (30m)**
- **All airspaces**
  - incl. Daily Airspace Bulletin Switzerland (DABS) by Skyguide
- **Takeoff and landing areas**
- **...**

Functionality 3rd Level

- **Technical Constraint**
  - **Additional devices**

- **Radio Communication (Glass as headset)**
- **Other aircrafts (FLARM)**
- **Live tracking**
- **Live weather data-**/events
  - Wind data from the ground sensors
  - Thunderstorms
- **Thermal information**
  - historical and predicted heat maps
  - Tracking data via FLARM
- …

User Interface

Glass Design Guidelines

- Design for Glass
  - Don't try to replace a smartphone
  - Deliver unique experience
- Don’t get in the way
  - Offer functionality that supplements the user's life without taking away from it.
  - Provide appropriate controls for your users
- Keep it relevant
  - Deliver information the right place and time for each of your users
- Avoid the unexpected
  - Don't send content too frequently and at unexpected times.
  - Get explicit permission before you do anything on the user’s behalf.
- Build for people
  - Design interfaces that use imagery, colloquial voice interactions, and natural gestures

Dark Cockpit

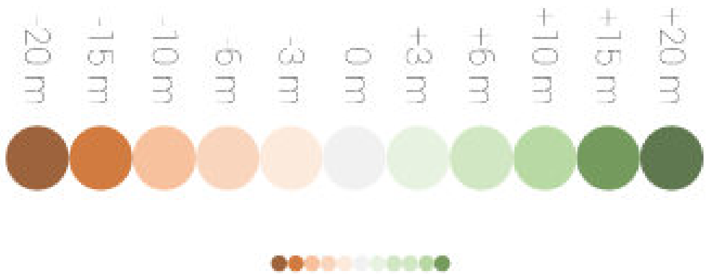
Glass has a different interaction concept than smartphones

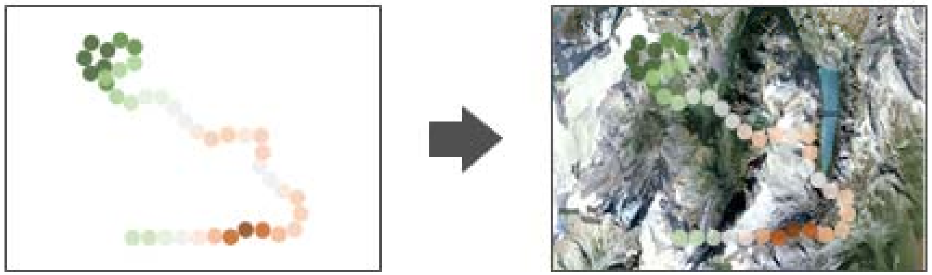
Cockpit in the Past

Cockpit Today: "dark" & Head up Displays

Design Styleguide - Use of Color

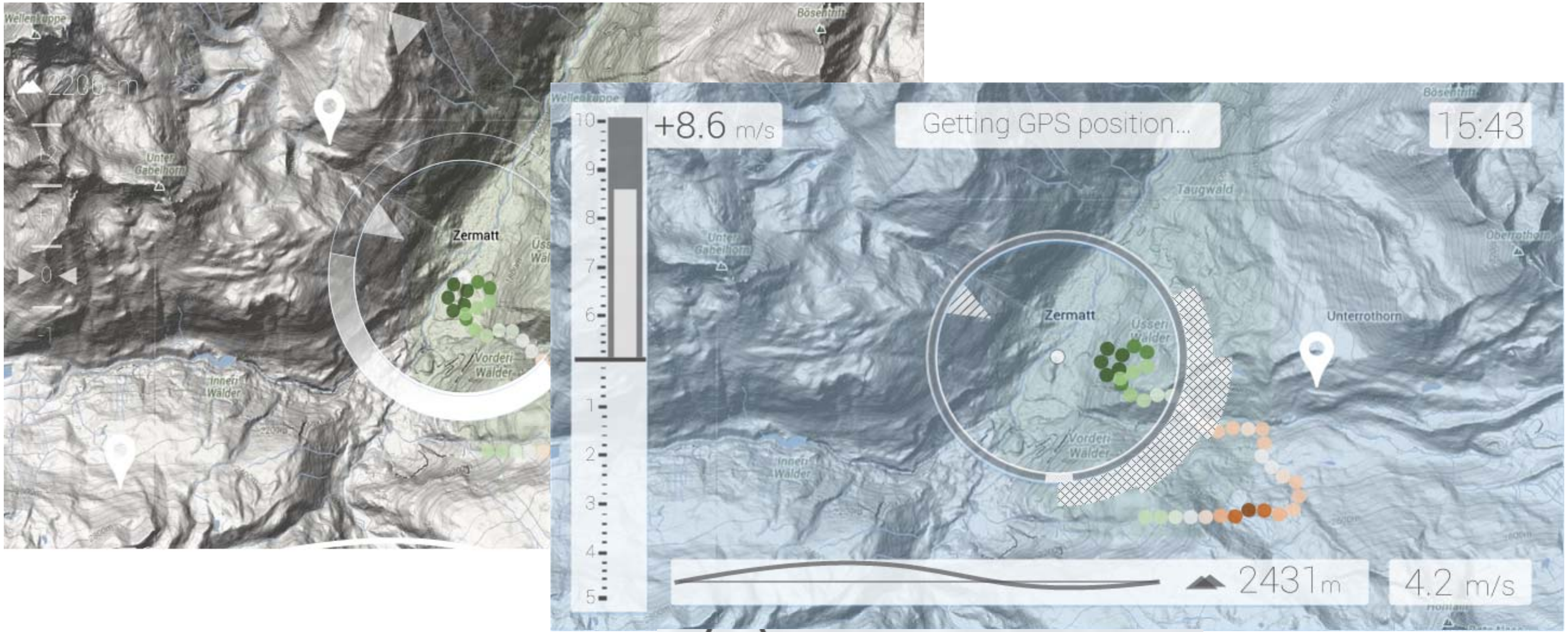
CSS Class	Hex	RGB
white	ffffff	255,255,255
gray	808080	128,128,128
blue	34a7ff	52,167,255
red	cc3333	204,51,51
green	99cc33	153,204,51
yellow	ddbb11	221,187,17

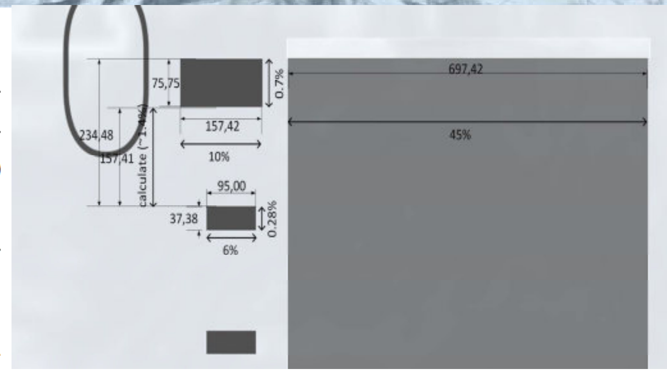




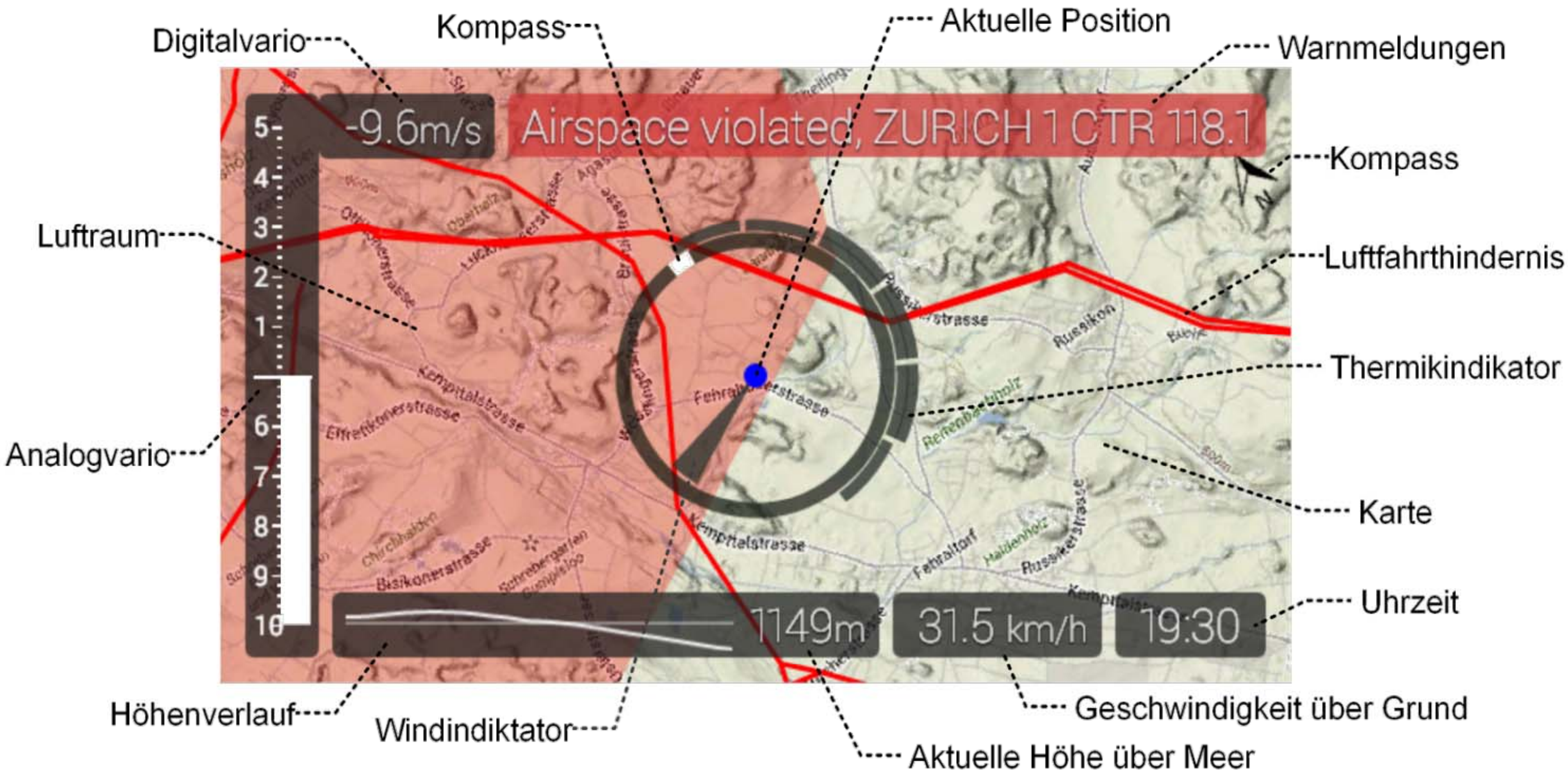
Design Styleguide - Screen layout

GUI Design Mockups - Map, Widgets, Fonts





Final Design



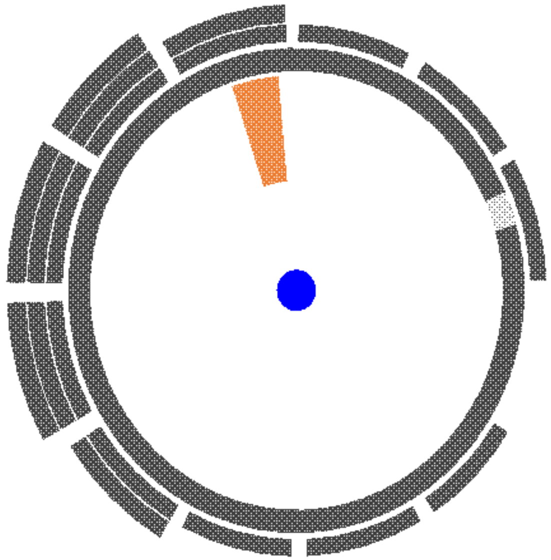
Magic Circle
Thermal & Wind Direction
Information

Magic Circle

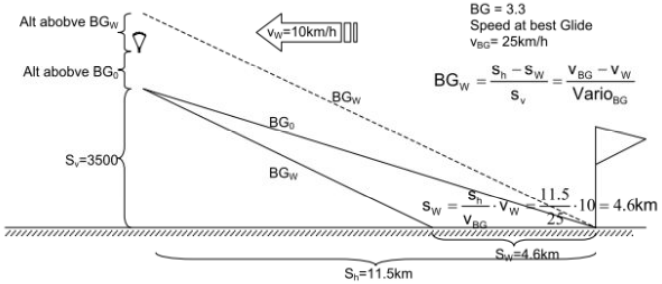
- Indication of wind direction
- Thermalindicator

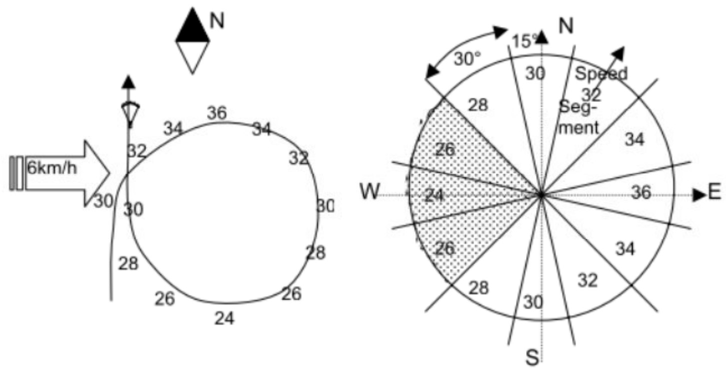
Wind Direction

- When cycling a the wind direction may be determined by the shift



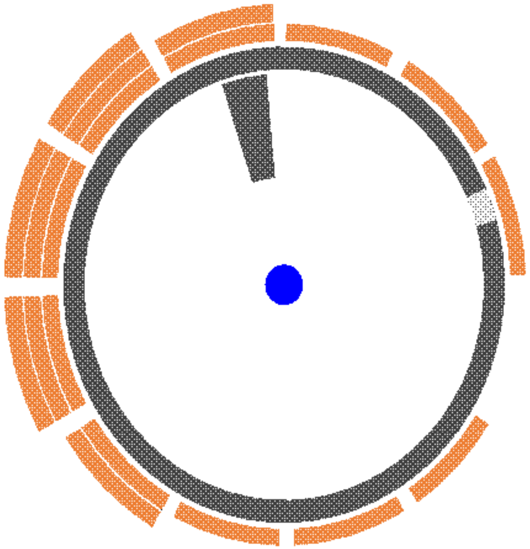
- An algorithm adapted from flytec
  - VWind = (Vmax - Vmin)/2

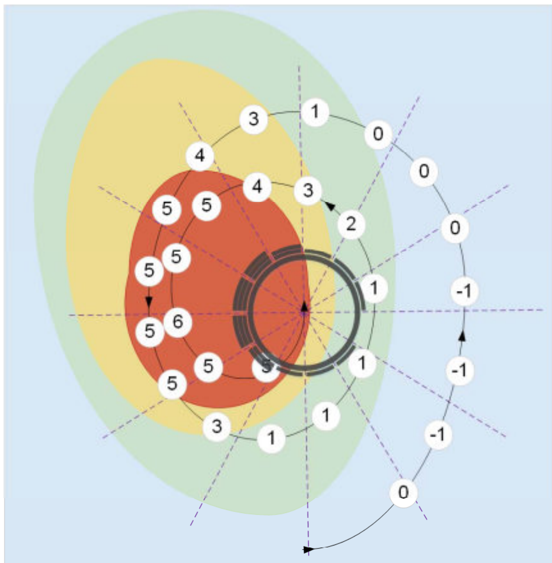


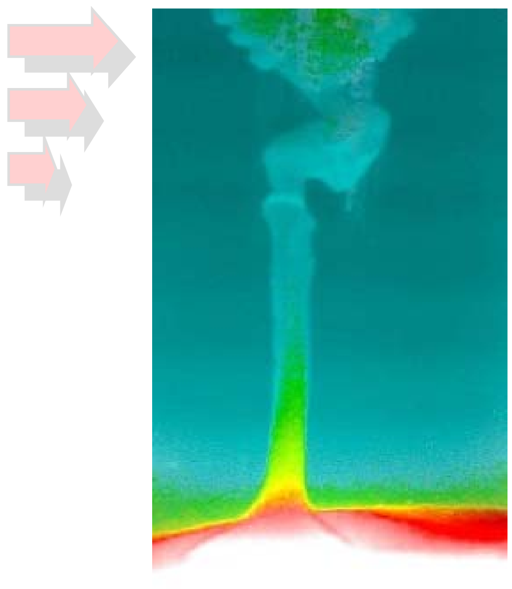


Thermikindikator

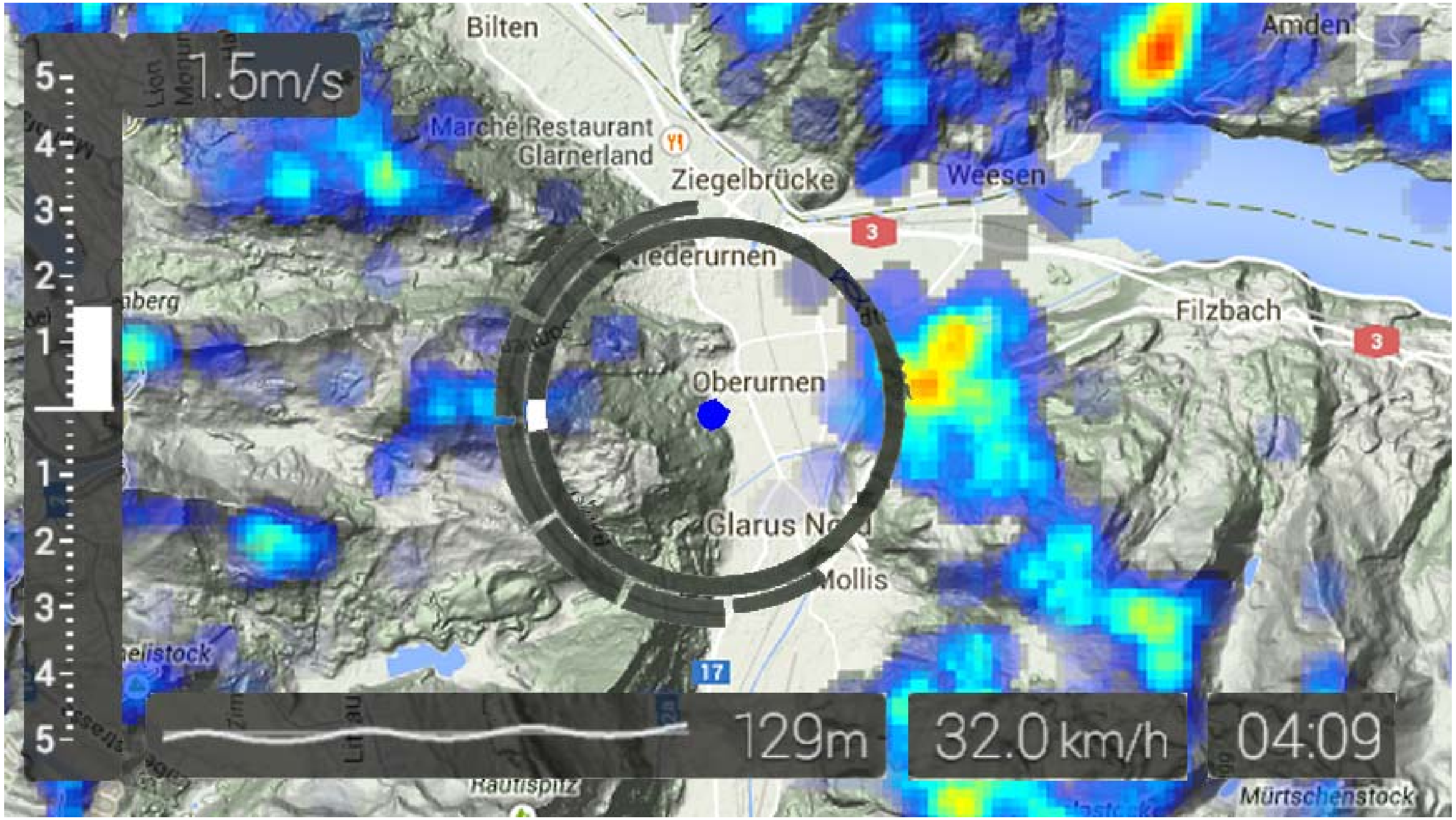
- Thickness of the ring indicate strength of thermal -> uniform perfectly centered
- Thermal displacement also influenced by the wind







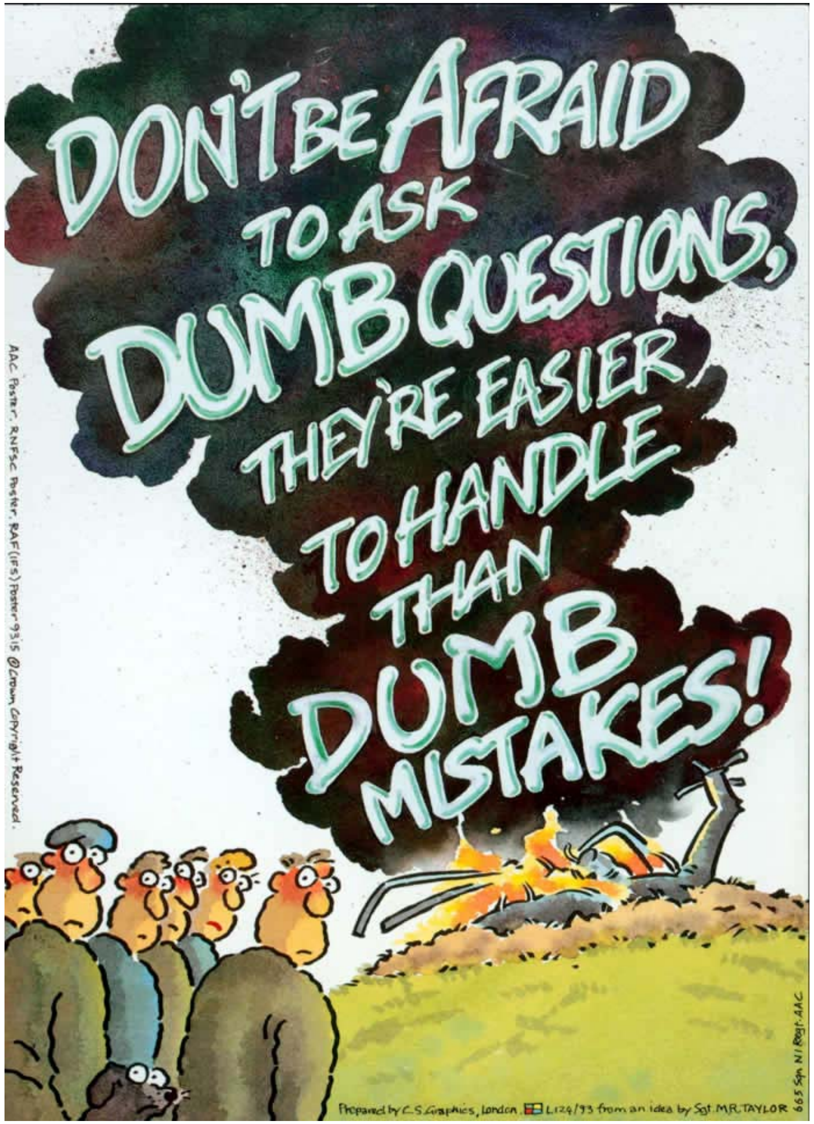
Next Steps - Show In-flight Thermal Hotspots



Video

Questions?

Questions?



or later

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