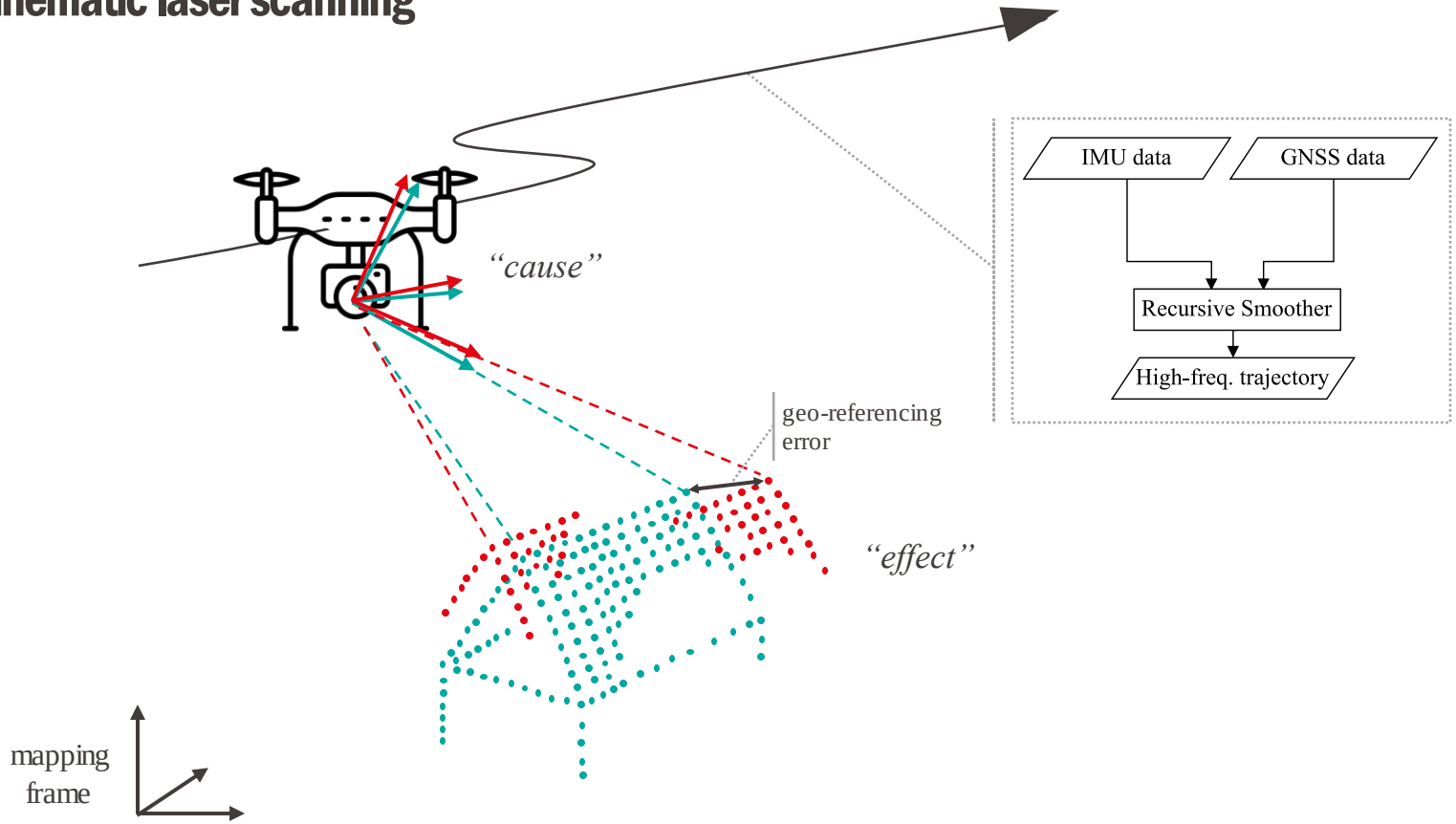
This project has received funding from the European Union Agency for the Space Programme under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004255. The content of this presentation reflects only the author's view. Neither the European Commission nor the EUSPA is responsible for any use that may be made of the information it contains.

On the benefit of concurrent adjustment of active and passive optical sensors with GNSS and raw-inertial data.

Kyriaki Mouzakidou, Davide A. Cucci, and Jan Skaloud

Direct geo-referencing – limitations

Kinematic laser scanning



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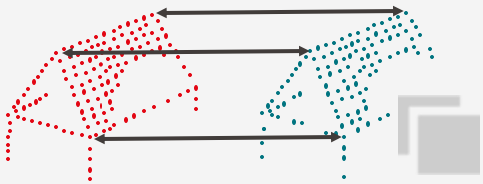
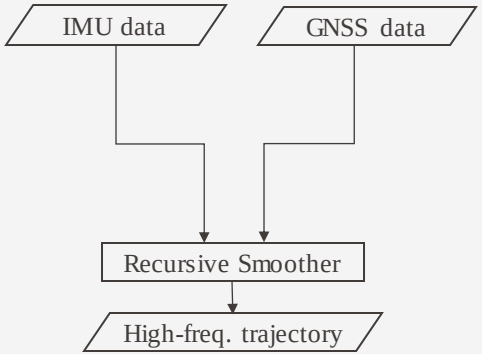
Correction approaches

☞ Target the "effect"
(point-cloud)

example:
Lidar to dense image matching point-cloud



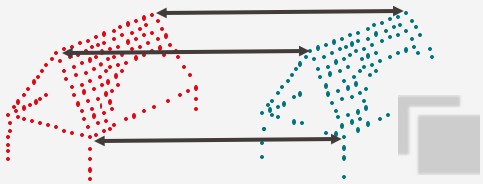
☞ Target the "cause"
(sensor - trajectory errors)



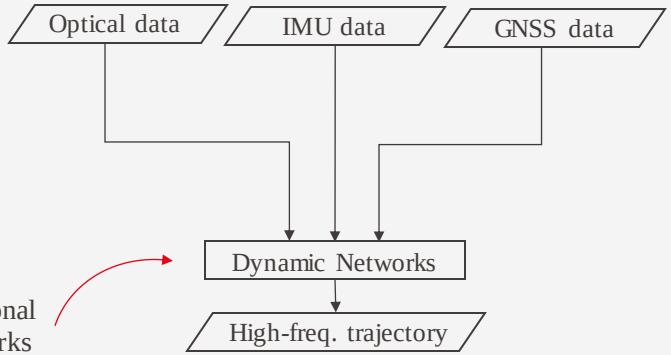
Correction approaches

☞ Target the "effect"
(point-cloud)

example:
Lidar to dense image matching point-cloud



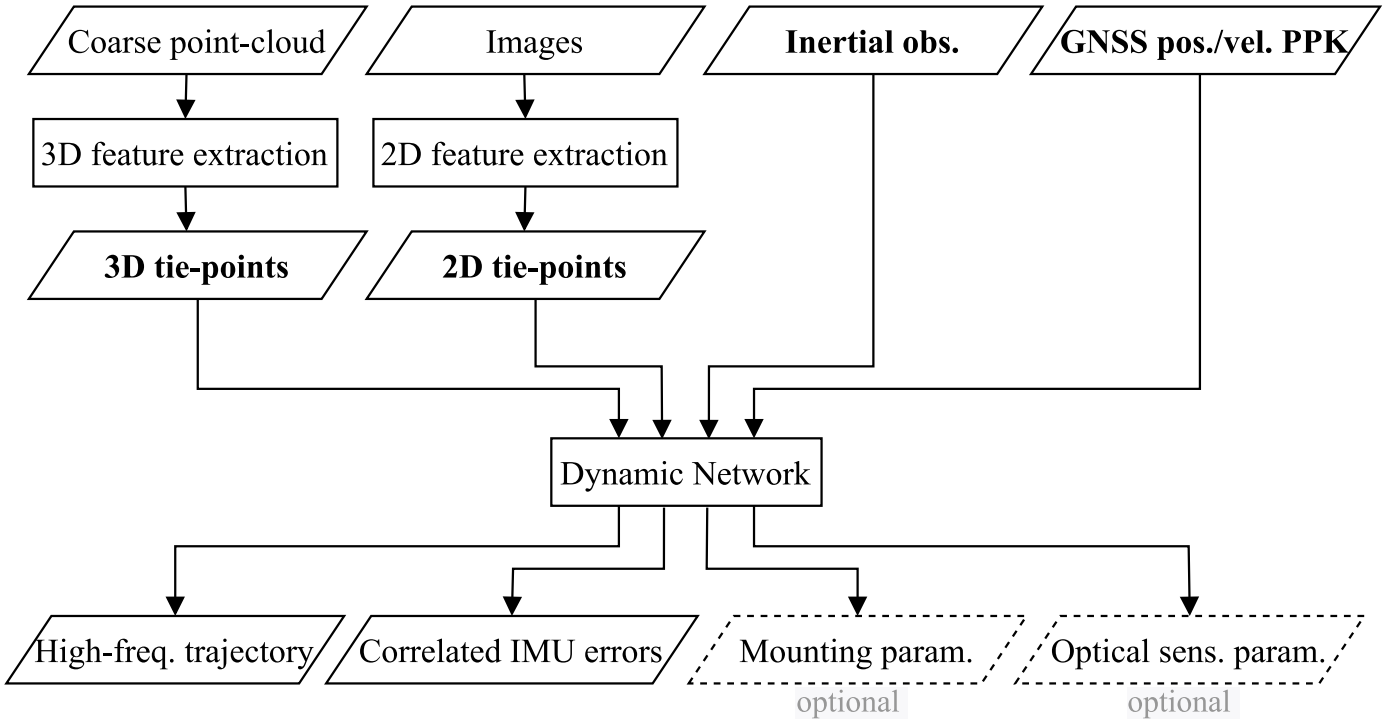
☞ Target the "cause"
(sensor - trajectory errors)



an extension of conventional geodetic networks

Colomina, I., Blazquez, M., 2004. **A unified approach to static and dynamic modeling in photogrammetry and remote sensing**. ISPRS Archives

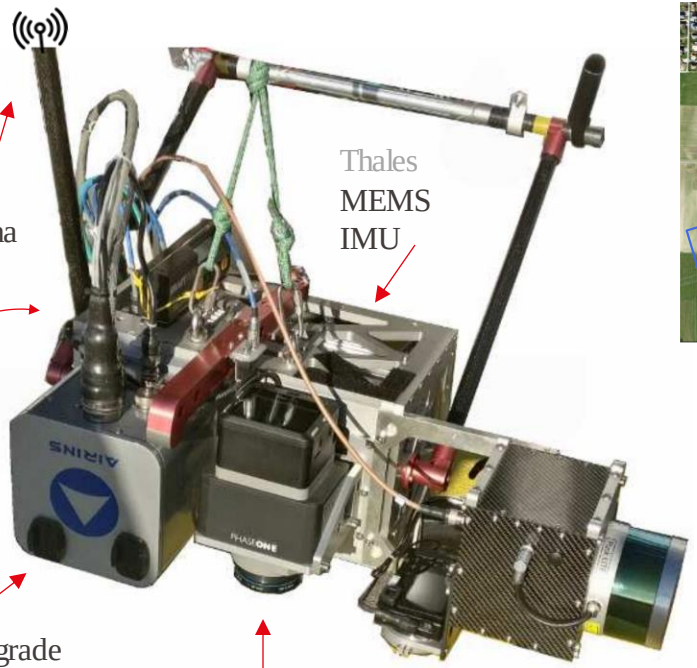
Proposed mutli-sensor fusion

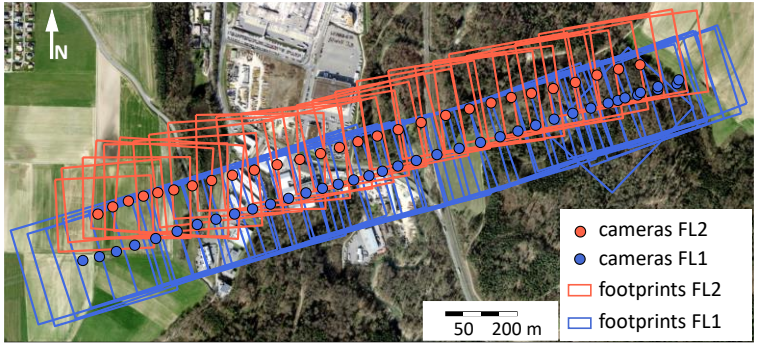


Cucci, D. A., et al. 2017. **Bundle adjustment with raw inertial observations in UAV applications**. ISPRS Journal

Brun, A., et al. 2022. **LiDAR point–to–point correspondences for rigorous registration of kinematic scanning in dynamic networks**. ISPRS Journal

Experimental evaluation





Trajectory determination approaches

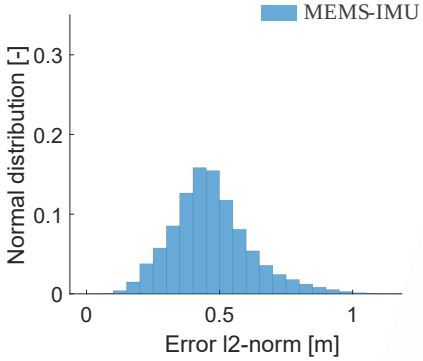
Reference (< 5 cm)

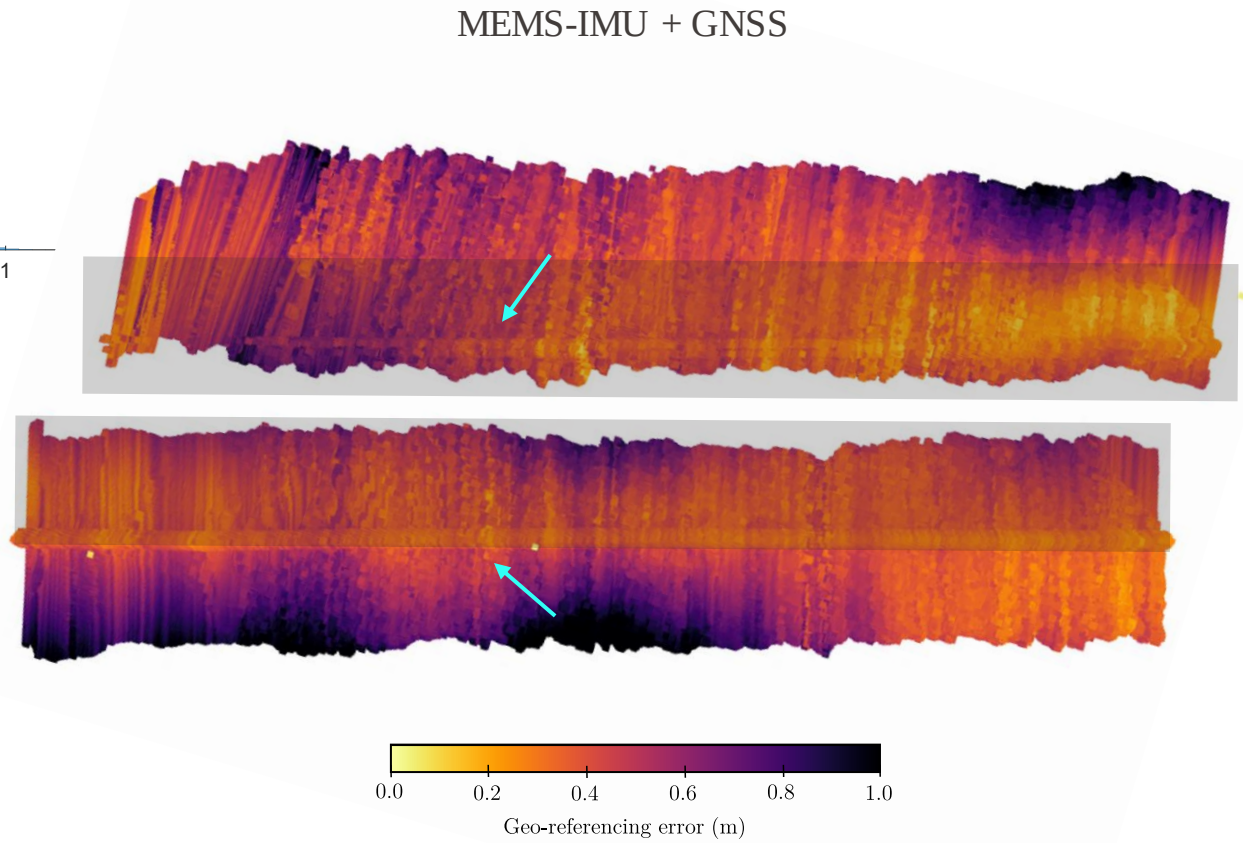
vs

1. MEMS-IMU + GNSS
2. MEMS-IMU + GNSS + Lidar
3. MEMS-IMU + GNSS + Camera
4. MEMS-IMU + GNSS + Lidar + Camera

Vallet, J., et al., 2020. **Airborne and mobile LiDAR, which sensors for which application?** ISPRS Archives

Direct geo-referencing – point-cloud error





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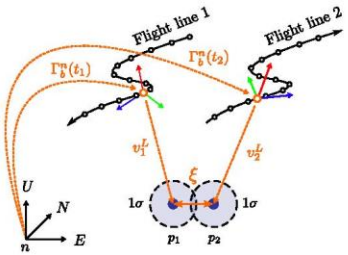
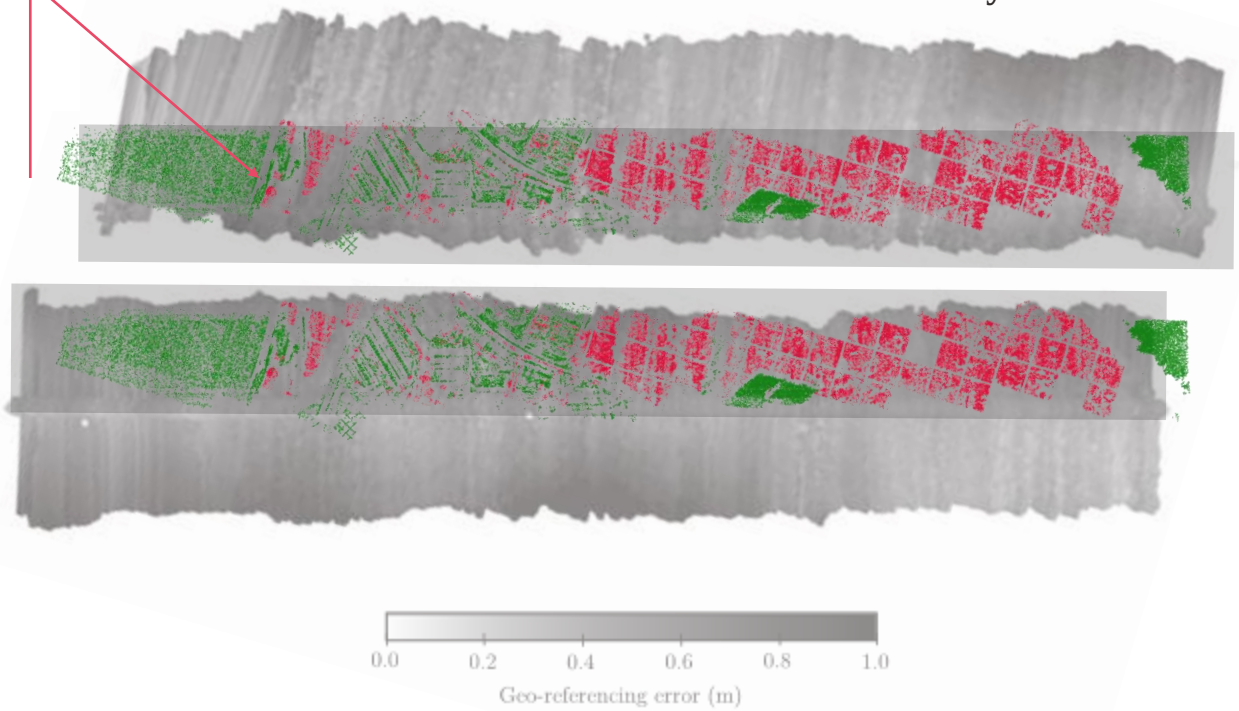
Use of 3D & 2D tie-points – point-cloud error



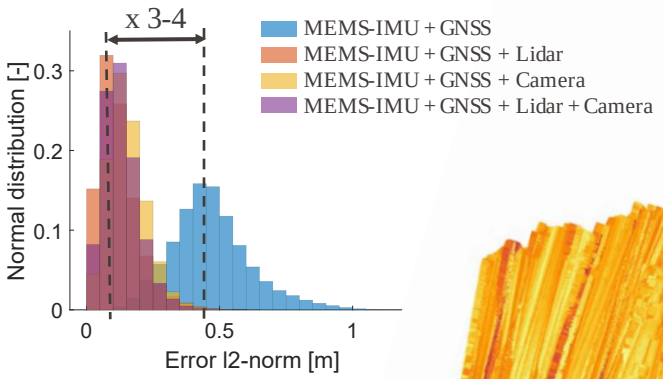
Brun, A., et al. 2022. ISPRS Journal

MEMS-IMU + GNSS

+ Lidar 3D tie-points
+ Camera 2D tie-points
+ within Dynamic Networks

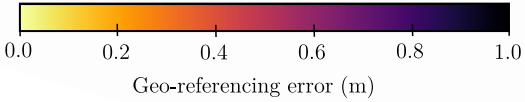


Use of 3D & 2D tie-points – point-cloud error



MEMS-IMU + GNSS

+ Lidar 3D tie-points
+ Camera 2D tie-points
+ within Dynamic Networks



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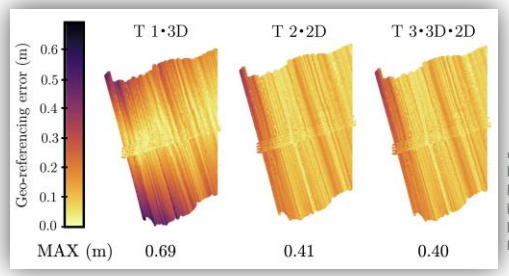
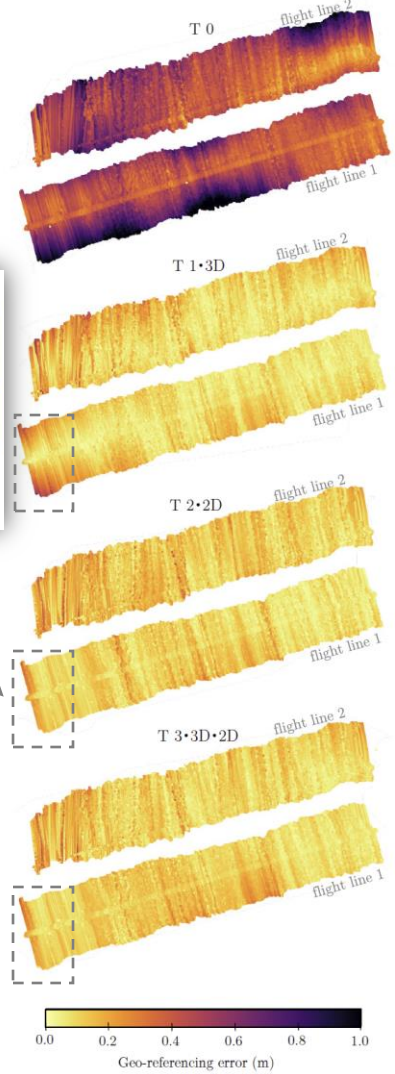
Conclusions

- ✓ Dynamic Networks {single adjustment of optical & navigation data}: **3-4 times reduced geo-referencing error**
- ✓ 2D tie-points & 3D tie-points: **continuous control** along trajectory





Want to know more?

- paper:
  Mouzakidou, K., Cucci, D.A., and Skaloud, J., 2022. On the benefit of concurrent adjustment of active and passive optical sensors with GNSS & raw inertial data. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*
- poster session

ODyN

Open source online
Dynamic Networks solver

Thank you!

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Acknowledgement

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